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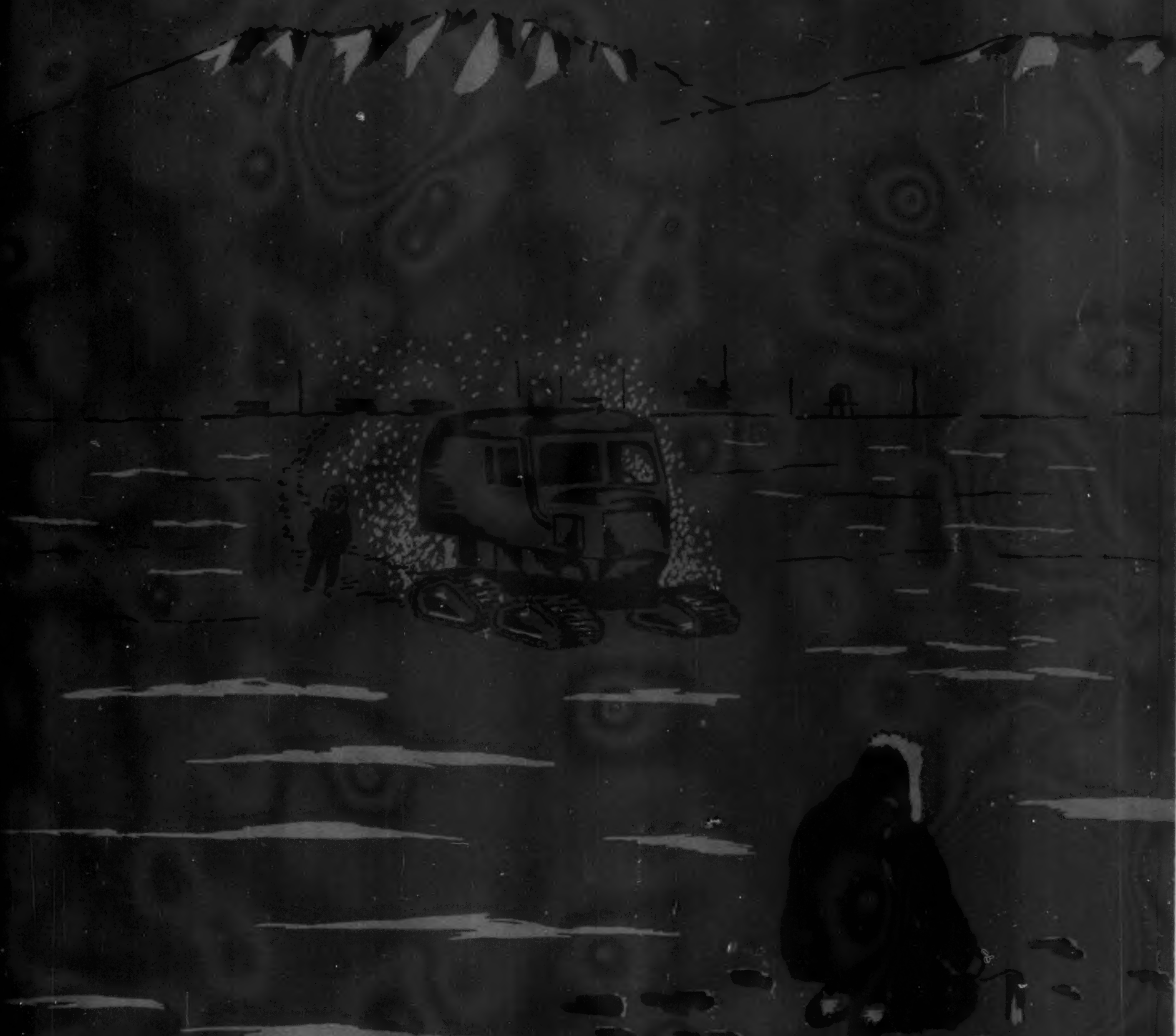
THE SCIENCE TEACHER



JOURNAL OF THE NATIONAL SCIENCE TEACHERS ASSOCIATION

THE SCIENCE TEACHER

The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

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THE SCIENCE TEACHER

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Editor's Column

We are again happy to welcome a TST Guest Editor. This month, he is Dr. Randall M. Whaley, Executive Officer, Advisory Board on Education, National Academy of Sciences-National Research Council, Washington, D. C.

Dr. Whaley, formerly Professor of Physics at Purdue University, is well known for his activities in and his sound approach to problems associated with pre-college science education.

RHC

It is becoming increasingly clear that we cannot afford the luxury of deep and bitter conflict in education. The complex problems that face us can only be solved if people from various segments of our national life find ways of working together. Fortunately, it seems that the prophet's admonition regarding the beating of swords into plowshares and spears into pruning hooks has been heeded here, as educators and academicians alike recognize that much more is to be gained by constructive action toward building a new education than by attempting to fix blame for present inadequacies.

It should be of particular interest and significance to the teachers of science that the major scientific societies in the United States are now recognizing that they have a definite and continuing responsibility for helping to plan education for the elementary and secondary grades. Within the past two years the American Institute of Physics has created a new position with a full-time Director of Education. The American Association for the Advancement of Science, developing and consolidating previous interests, similarly created a permanent position with a mathematician serving full time as Director of Education. In like manner, the American Chemical Society has within the past year added to its staff a university chemist for full-time coordination of the Society's education programs, which, more than ever before, relate to science in the schools.

The American Institute of Biological Sciences, the American Geological Institute, and the Mathematical Association of America are examples of other societies which have also established committees in education, staffed with university scientists and working with teachers on problems of curriculum development, teacher education, and more effective use of films and other aids in the classroom. Slightly over two years ago, the National Academy of Sciences-National Research Council created an Advisory Board on Education with a full-time Executive Director to represent the Academy-Council in educational matters. The Board is seeking to identify critical issues in science education that might best be attacked by combined efforts of scientists from all fields.

Never before has there been such serious intent, so much recognition of responsibility, and so much willingness on the part of scientists to work with teachers and educators in general. Many NSTA members saw evidence

of this spirit of cooperation at Bowling Green last June as participants in the annual meeting of the National Commission on Teacher Education and Professional Standards. For the first time the TEPS conference was co-sponsored by national groups representing science through the AAAS and the NAS-NRC, and the humanities through the American Council of Learned Societies. Nearly one quarter of the more than one thousand invited participants came from liberal arts departments in universities and colleges.

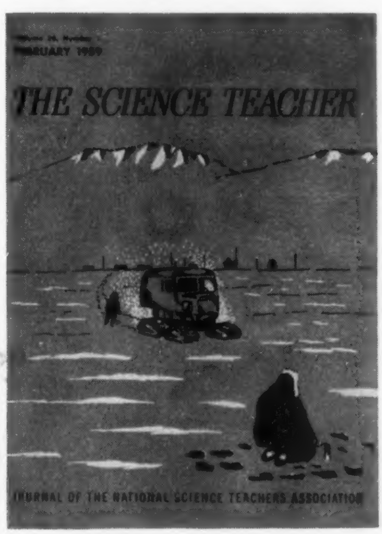
Other teachers are finding out from personal involvement in numerous curriculum study groups, such as the ones in physics, at MIT, in mathematics at Yale, and in biology at the University of Colorado, that scientists are willing and able realistically to come to grips with problems of science education in the schools.

And money to carry through these and other important programs is available. The greatest increase in appropriation to the National Science Foundation last year was for expanding four-fold its activities in science education. The U. S. Office of Education has nearly 250 million dollars a year for the next four years to expend in a variety of specified directions that could catalyze action all over the country for long-range improvements in teaching, curriculum materials, and in procedures for guidance and counseling.

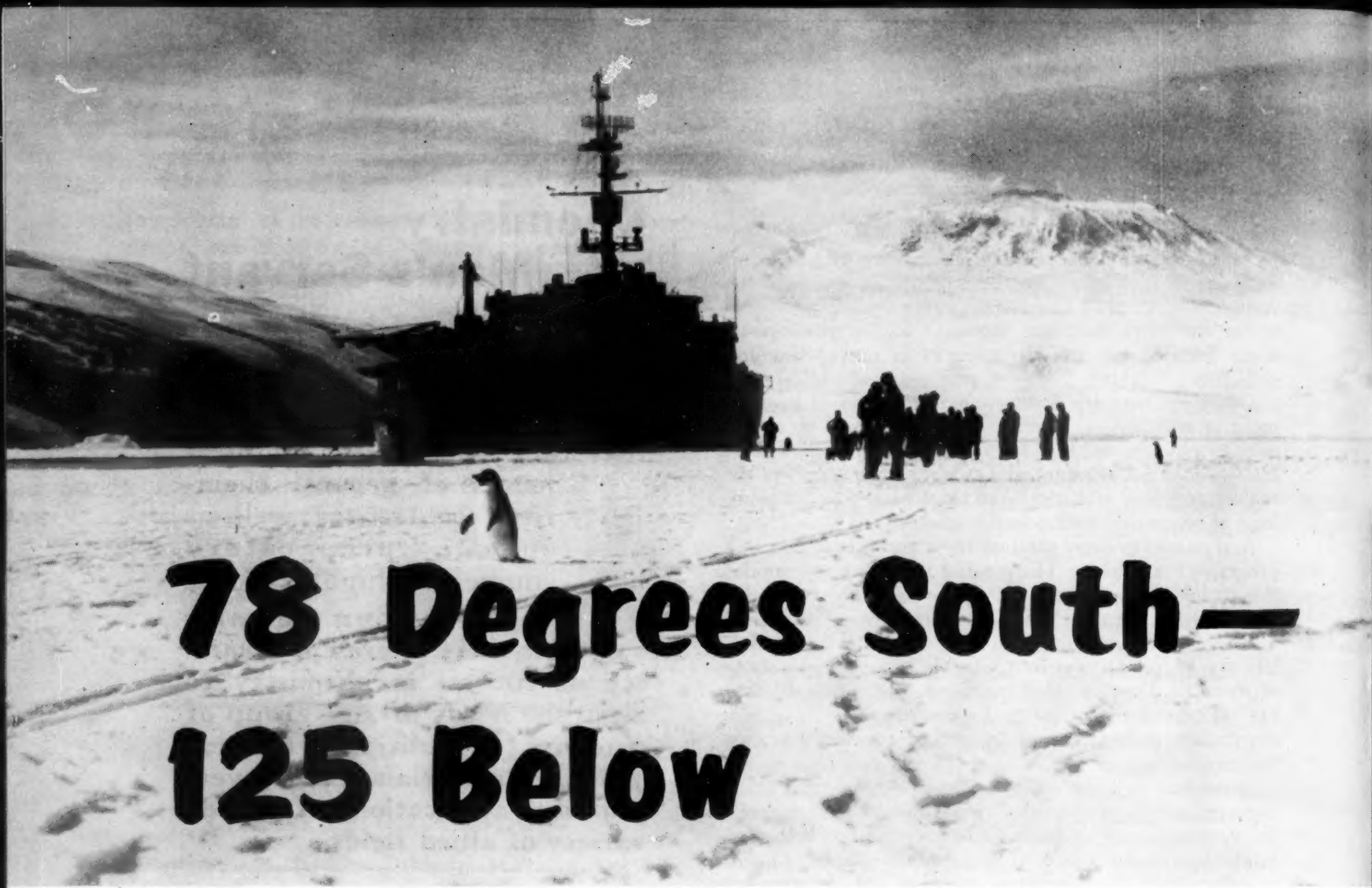
It remains to be seen how effectively we seize these unprecedented opportunities. Those administering funds must recognize and take full advantage of the help now available and gladly offered by scientists who have much to offer from their vantage point at the frontiers of science. Radical departures from traditional practice may be required. We must not be prevented from tilling the fertile and vast educational field because we used our time and money merely to make deeper ruts out of the old paths.

RANDALL M. WHALEY

THIS MONTH'S COVER . . .



Ice, snow, and bitter cold confront the isolated scientist in the bleak half-light of antarctic winter at "78 Degrees South—125 Below."



78 Degrees South—125 Below

By GORDON CARTWRIGHT

Meteorologist, U. S. Weather Bureau, Washington, D. C.

ON August 25th, 1958 a muffled figure emerged cautiously from a tiny cluster of buildings and shuffled slowly across the rough snow surface to a collection of masts and louvered boxes 50 meters distant. He clutched an electric torch in a heavily mittened hand and bent low to protect his face against the slight breeze from the northwest. The electrically heated suit made his gait awkward. The snow creaked like a hundred wagons in spite of his soft felt-soled fur boots. His colleagues waited apprehensively inside for his return, for the short distance was filled with danger. It was a moment of intense interest. Inside the houses the remote reading instruments had told them it was extremely cold outside. What would the readings directly from the special thermometers register at this time?

One of the waiting group was also heavily dressed, standing in the narrow vestibule of the sled house should an emergency arise. After what seemed an hour, the solitary figure creaked noisily back to the house through the polar darkness. His waiting companion hustled him smartly through the vestibule into the brightly lighted room. Instantly his heavy fur clothing turned a gleaming white with frost, as his friends eagerly helped him jerk off the unpleasant costume to hear the news. For this man had just been exposed to the lowest temperature ever experienced by any one on the surface of the earth. It was an incredible 125.3° Fahrenheit below zero outside their house!

The place was 78° 27′S, 106° 52′E, at the location of the Russian IGY station VOSTOK, situated 1400 kilometers inland from their main base at MIRNY and high on the great ice plateau of East Antarctica. Several times earlier in the winter, the temperature had fallen well below the record figure of −102° F measured the previous year at the American IGY station at the South Pole. Now, with this latest measurement, there could be no question that here was the nadir of life, THE COLDEST AREA ON EARTH.

By contrast, on this same day in August, the temperature in Cow Creek, Death Valley, California was 118° F ABOVE zero, 243° F warmer!

The temperature at VOSTOK had exceeded by five degrees the estimates of U. S. IGY planners of the lowest temperature that would be found in the Antarctic. It had even exceeded the theoretical

minimum calculated by the Russians themselves on the basis of data then available from Antarctica.

All around the Antarctic, weather observers at the more than 50 stations built by 12 different nations were struggling against bitter cold, high winds, or stinging snow to take measurements at the last great unknown on the globe—ANTARCTICA.

But why were the Russians living at the coldest spot on earth? And how had all the other meteorologists in Antarctica been persuaded to give up a year or more of normal living to fight the elements in the most inhospitable continent of the globe? It all grew out of a meeting of the Joint Commission of the Ionosphere in Brussels in 1950 when it was recommended that a Third International Polar Year be held in 1957-58. The idea caught on, and was shortly supported by most of the other important international scientific unions. By 1952, it had gathered such momentum that the International Council of Scientific Unions, the coordinating body for most world science, appointed a special committee to plan and coordinate the programs for the new International Geophysical Year.

One of the first principles agreed by the special committee was that the investigations should embrace the whole earth instead of concentrating on the polar regions, as had the earlier years. But somehow the Antarctic could not be set aside lightly. The challenge of such a vast geophysical blank spot was one that neither scientist nor seasoned explorers could resist.

Thus were laid the plans for a series of explorations beyond the wildest hopes of Scott or Amundsen. More than 5000 men and 30 ships have been battering at the ramparts of the Antarctica in summer, launching their respective teams of scientists into the long winter season with a bewildering variety of scientific instruments, machines and airplanes, prefabricated buildings, and hundreds of tons of food from caviar to pemican.

At Mirny Base

The Soviet expeditions cooperating in this complex program had agreed to concentrate their efforts over a broad region of East Antarctica, one of the least known areas of the continent. In January of 1957, their 3 expeditionary vessels brought the wintering-over party of 180 scientists and technicians, including 27 weather men, to the main operating base at Mirny. Here, on the edge of the continent and barely inside the Antarctic circle was to be the focal point for a complex scientific attack on the mysteries of this great white desert.

These weather men brought with them experience, enriched by numerous arctic and sub-arctic expeditions. They were seasoned veterans in the tough game of polar explorations. The area in which they were to live and work challenged them for several reasons. It contained two unique spots on the continent: the geomagnetic pole and the *pole of inaccessibility*.[1] It was believed to be an area relatively undisturbed by high mountain chains or deep oceanic basins. Further, it was one of the great blank areas from which weather data was urgently needed in order to understand the circulation of the atmosphere over the polar plateau. It was with this group that I, the only American,[2] was to live and work for fourteen months as a U. S. member assigned by the National Academy of Sciences to the Russian expedition.

Gordon D. Cartwright is the Coordinator of International Activities for the U. S. Weather Bureau. A native Pennsylvanian, he first joined the Bureau in Pittsburgh. After an observer apprenticeship at a number of weather stations, he attended New York University and received his degree in meteorology. During World War II, he served as liaison weather officer on projects with our allies. Since his return to the Washington headquarters, his assignments have taken him to all continents of the world from 82°N to 70°S, in addition to the Arctic expedition with Russian scientists.

The most fundamental question one can ask about the Antarctic is "How did this vast ice continent come into existence, and why is there such a great contrast between it and the Arctic?" Here is where the meteorologist comes into the picture. For Antarctica is a continent formed primarily by the processes of weather. While our knowledge of it is still sketchy and many facts being piled up during the IGY must be painstakingly analyzed before we will have an accurate answer, the broad circumstances which produced Antarctica may have been somewhat as follows: (1) There existed within the Antarctic Circle at least the skeleton of a continent or a series of archipelagoes on which the snows of winter could collect; (2) Surrounding these were the warm, unrestrained waters of the Atlantic, Pacific and Indian Oceans providing an unlimited supply of moisture; (3) There was a deficit of heat over a large part of the area.

[1] This term has been applied to that area of the Antarctic most distant from the edges of the continent. Up to this time, it was considered as probably the most "inaccessible" area to reach by surface means.

[2] For a personal account of the author's experiences with the Russian expedition, see *The Saturday Evening Post*, October 18, 1958. p. 24.

With such a combination of circumstances, whenever the earth moved into a period of generally declining temperatures, or of increased snowfall, the snows of one winter were carried over into the next. The slow spreading of this white blanket tended further to reduce the available heat energy by reflecting the sun's rays of summer and by affording a more effective radiation surface during winter. Spreading over the interlaced seas, this growing ice sheet also tended to cut off the warming effect of the oceans, and temperatures continued to drop lower and lower.

Then another factor began to enter the picture. As the snows accumulated, the general level of the expanding ice sheet began to rise. The moist air streams blowing across it from the surrounding seas were also forced upward, tending to produce greater amounts of snowfall (just as the heavier snowfall is commonly found on the windward slopes of mountains). Up to a certain point, beyond which further increase in height caused little or no increase in snowfall, this was an accelerating process.

Thus, one of the vital objectives of the Antarctic programs was to learn how the weather processes operate to maintain such an enormous ice mass which now is losing countless millions of tons of its substance each year by the chipping off at its edges of many thousands of icebergs. To find the answer it would be necessary to make observations at a number of places over the continent. These observations would have to be made for at least a year, and preferably continued much longer.

The Russians, in consultation with the other 12 countries interested in the Antarctic, agreed to set up six weather stations in East Antarctica in the region of 90° East Longitude. At least three of these stations would be placed deep in the interior in an area seen only fleetingly from aircraft, but one that was believed to be the highest and possibly the most difficult to reach—on the whole continent.

Men and equipment to combat the elements of the Polar Cap.

After a bitter struggle with intense cold and feathery snow that bogged down heavy tractors and made aircraft landings dangerous, the station VOSTOK was established at the geomagnetic pole, and the station SOVIETSKAYA pushed to within a few hundred kilometers of the *pole of inaccessibility*. Here at VOSTOK, living under conditions that one might expect to find on a different planet, were assembled the weather probers. Here in summer was a world of constant blinding whiteness, a sky filled with glittering crystals painting surrealistic patterns in space and confusing one's vision; in winter a world of brilliant blackness, with the silent aurora causing the heavens to come alive with fresh fantasies. And always, bitter, raw cold reaching such intensity as to create a whole new set of circumstances, in which ordinary materials lose their familiar properties and strange things happen without apparent reason. Living at an altitude of 3500 meters above sea level, the men are harassed by sleeplessness, loss of appetite, and difficulty in breathing. There is nowhere to go for recreation or relief. Even if there were, it would be next to impossible to get there, for the feather-soft snow and bitter cold is a formidable barrier surrounding them like a wall. Here our small group, living in the most bitter isolation known on our planet, carried on a steady routine of observations of the weather; they studied the characteristics of the snow and measured the changing magnetic field of the earth. They kept detailed records of the aurora, and other phenomena. But their most onerous task was the struggle each day to launch big balloons carrying miniature weather stations aloft to measure the condition of the atmosphere above the frigid plateau. While such observations are made at many stations over the world, here at VOSTOK (and at the other interior stations, such as the Amundsen-Scott station at the South Pole), the job becomes one of painful difficulties, requiring great skill and perseverance. Even though carefully conditioned in advance by soaking and heating, the big balloons once inflated and exposed to the extreme low temperatures are likely to take on the character of a paper-thin sheet of glass, shattering at the slightest jar. Static electricity creates a constant threat of explosion of the hydrogen gas used to inflate the balloons. The extreme dryness and low temperature of the atmosphere cause freak electrical

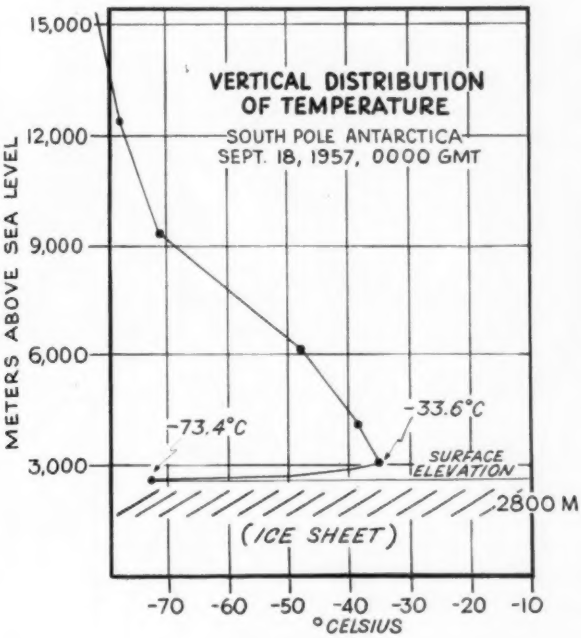


Figure 1

On the day of the upper air sounding illustrated in the diagram, the temperature about 400 feet was 39.8° warmer than it was at the surface itself.

and radio problems with the tiny transmitters which go aloft on the balloon to send back the weather data to the station.

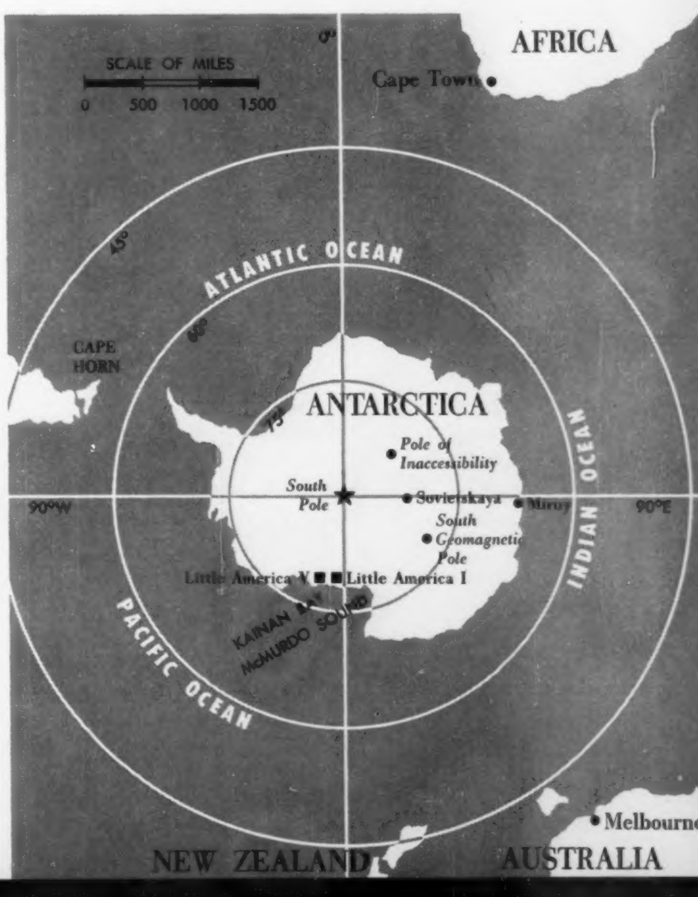
What is the reason for this effort, and why should man be subjected to such extreme hardships? Out of the heroic struggles of these meteorologists here and at the other stations throughout Antarctica—and especially those located deep in the interior—the true picture of the weather processes over this unique continent is being unveiled for the first time in history. We see now that the incredibly low temperature being suffered by the isolated meteorologist on the high plateau represents only a very thin layer of the atmosphere at the surface. (*See Figure 1.*) A few hundreds of meters above his head the temperature is "pleasant," as the atmosphere is no colder than it is in the middle west of the United States in winter.

By piecing together the data from a number of stations, we are beginning to see how this thin skin of cold air drains steadily off the high plateau of the ice sheet, gathering speed as it flows, much like water, down the steep slopes near the edge of the continent, chiseling and hardening the surface into fantastic zastrugi (eroded shapes) and transporting great quantities of snow out towards the sea again.

It also seems that cyclonic storms rarely penetrate into the high plateau region of East Antarctica, although they do travel regularly across the lower elevations of the ice sheet between the Ross and Weddell Seas. This gives rise to the great storminess of these areas and explains why even the remote station at the South Pole has had surprisingly strong winds. We are beginning to see how the warm, more moist air is transported aloft into the interior of the continent, where it loses both its heat and moisture, nourishing the ice sheet and keeping the temperatures near the surface from falling to even more bitter extremes. Chilled, the air eventually finds its way back to warmer latitudes, where it acts again to moderate the heat of the tropics, thus helping to keep the distribution of temperature over our planet within habitable limits.

What it is that controls the general movements of these winds and the outflow from the continent may become known when the thousands of upper air observations made during the IGY can be assembled and analyzed by skilled meteorologists working in laboratories far removed from the hardships of the Antarctic areas. The meteorologist will collaborate with the glaciologist to compare the information taken from deep within the ice sheet itself with that taken from the atmosphere. Such facts are valuable in studies on the climate of the past, and their relation to the present.

(Continued on page 68)



Camping with Accent on Science

By IRWIN SLESNICK

University School, Ohio State University, Columbus

OUTDOOR education through school camping programs has grown throughout the United States to the extent that in many regions it is considered an important ingredient of the on-going school curriculum. Coupled with the objective to enrich the physical education program with outdoor recreation is the aim to inspire wholesome conservation attitudes and practices. The University School at the Ohio State University, in order to better realize the latter objectives for its camping program, refined its 1958 junior high school field experience. The school administrators and the involved grade counselors requested that the high school science staff assume the major responsibility for organization of the instructional camp program.

It was generally agreed that in order for the students to gain a respect, an appreciation, and a knowledge of nature, fundamental details of nature embodied in specific disciplines should first be introduced to the students. Conservation was therefore to be taught inductively with six specific disciplines (entomology, botany, vertebrate zoology, ornithology, geology, astronomy) providing the material for concepts preparatory to the formation of conservation generalizations.

Seven weeks prior to the time when sixty-three of the seventh and eighth graders were to leave for camp, the science preparatory program was begun. Specialists in each of the above mentioned disciplines were scheduled to make an introductory presentation on Monday of each week. In each case, the specialist who made the presentation was the individual who later accompanied the group on the week's camping trip.

The first week of the conservation unit study concerned entomology. The "expert's" presentation did not attempt to cover the field but, rather, endeavored to excite and stimulate interest which the grade group utilized in the intensive work which followed. The entomologist spoke of the great diversity of insects, the many ways they affect man and the fascination of observing and studying the anatomy, physiology and the behavior of a single specimen. He showed the combined grades an extensive insect collection, an experiment in progress and the basic equipment of an entomologist. Throughout the presentation special studies were suggested and one common laboratory exercise with living specimens was assigned. He left with the grade teachers a list of available books, films and suggested field trips.

Each succeeding week a new field was explored. Again the natural history specialist, either from the University School staff or from the community, inspired the group with knowledge and spirit of, and reverence for, details in the design of nature.

During the final week before leaving for camp, each specialist made one appearance before the group to outline the nature of the field experience in his area; listing the equipment needs of each student and the needs of those students who were planning individual projects with his guidance.

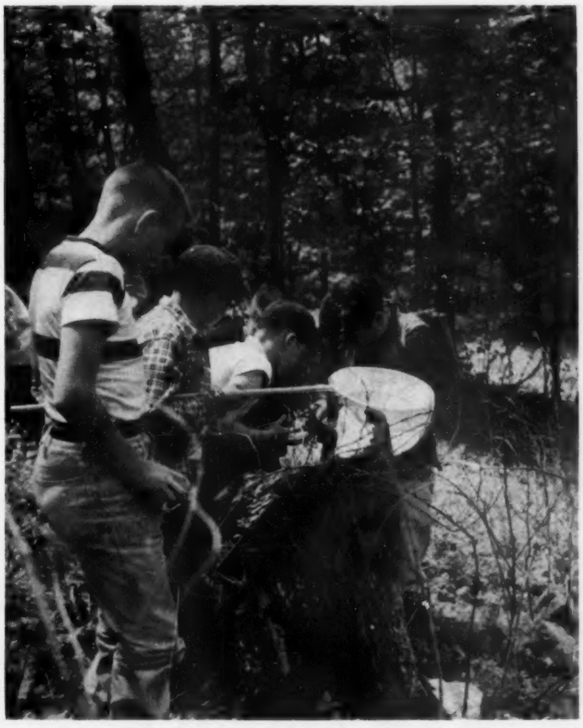
The author instructs the camp group on subject material and the environment to be explored.

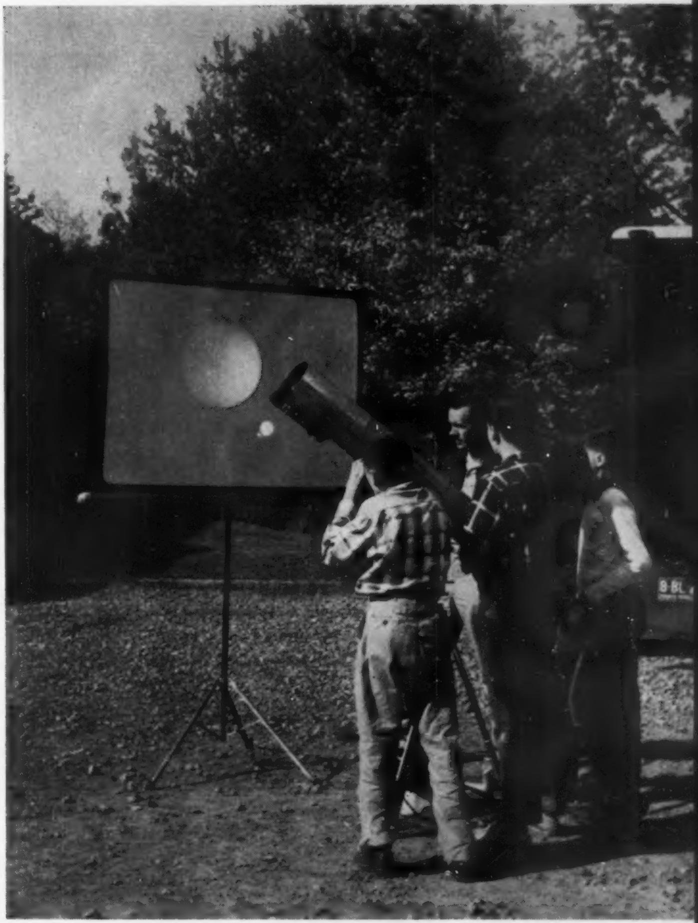
Time	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
5:30		Reveille Bird Hike	Reveille Bird Hike	Reveille Bird Hike	Reveille Bird Hike	Reveille Bird Hike
6:00		Bird Hike A	Bird Hike B	Bird Hike C	Bird Hike D	Bird Hike (open)
6:30		Reveille	Reveille	Reveille	Reveille	Reveille
7:30		Breakfast	Breakfast	Breakfast	Breakfast	Breakfast and Pack Lunch
8:15		Inspection	Inspection	Inspection	Inspection	
8:30		Classes A. Geology B. Entomology C. Vertebrate Zoology D. Botany	Classes A. Entomology B. Geology C. Botany D. Vertebrate Zoology	Project	Project	Reports (9:30) Evaluation (10:30) Clean up
11:15		Recreation	Recreation	Recreation	Recreation	
12:00		Lunch	Lunch	Lunch	Lunch	Leave camp
1:15	(2:00) Leave for camp	Classes A. Botany B. Vertebrate Zoology C. Entomology D. Geology	Classes A. Vertebrate Zoology B. Botany C. Geology D. Entomology	Project	Project	
4:30		Recreation	Recreation	Recreation	Recreation	
6:00	Picnic	Dinner	Dinner	Dinner	Dinner	
7:30	Eve. Rec.	Eve. Rec.	Eve. Rec.	Eve. Rec.		
8:00	Astronomy D	Astronomy C	Astronomy A	Astronomy B	Reports	
9:00	Snack	Snack	Snack	Snack	Snack	
9:30	Get ready for bed	Get ready for bed	Get ready for bed	Get ready for bed	Get ready for bed	
10:00	Lights Out	Lights Out	Lights Out	Lights Out	Lights Out	

The Future Farmers of America camp in the Ohio Muskingum Conservancy district had been selected as the 1958 campsite. The group arrived on Sunday, May 18, and stayed for five days. Students were previously assigned to study groups of about sixteen. The groups were designated A, B, C, and D. Soon after arrival on Sunday groups B and C met with the vertebrate zoologist who organized the trapping exercise preparatory to class work on the following day. As can be noted from the schedule (page 12) the astronomy group (D) assembled at 8:00. (The science staff with its equipment arrived at camp several hours before the students. They set up laboratories in the recreation hall and reconnoitered the area for the field work).

The ornithology and astronomy classes met formally for four days while classes in entomology, botany, geology and vertebrate zoology were scheduled for four sessions on Monday and Tuesday. The work of the class groups was thoroughly planned, yet the schedules were flexible enough to adapt to weather changes, "rare finds" etc. In botany, for example, each student planted a pine tree on a hillside, sought unusual flora, keyed out at least one tree and one wild flower, viewed the ecology of a north-south slope, noted relationships between kinds of plants and environment—yet no two class sessions were identical.

Finding live specimens.





A specialist prepares the group for field study and explains the proper use of instruments, and how to make observations in the study of Astronomy.

Throughout the planning period at school and the class sessions at camp the instructors were pointing out possible individual projects which could be undertaken during the four large blocks of time on Wednesday and Thursday. In many instances students had begun project work before arriving at camp. Most students had already identified the general field in which they planned to work. By Wednesday morning each student had met with an instructor to discuss the procedure he would follow during the two project days.

Typical of the projects undertaken were: a study of the biology of the tent caterpillar, observations of sun spots, geological mapping of the camp area, identification and lyrics of bird calls, and identification and casting of animal tracks. Several students who wished to specialize in all fields received much satisfaction from making a general natural science survey of a given small area.

ABERRATIONS IN DISCUSSIONS OF NEWTON'S LAWS

By L. W. PHILLIPS

Department of Physics, University of Buffalo, New York

PART TWO

(Part One appeared in the December issue.)

NEWTON'S Third Law is probably the most misunderstood and misinterpreted law in high school physics. So easily compressed into a nice, simple "action equals reaction," it lends itself so very readily to the misinterpretations that usually arise from compressed "simplified" physical laws. No doubt somewhere, if one but took the time to look, he could find an example going somewhat like this: "Action—Boy kisses Girl. Reaction—Girl slaps Boy. Action equals reaction." While this particular example has not been found in any of the currently-popular high school physics textbooks, some of the ones that do appear are in almost the same category. One book describes the standard experiment with a row of balls suspended, pendulum-like, in contact with one another. A ball at one end of the row is pulled aside and released; it falls back and collides with the row, and a single ball at the other end of the row pops out. Then:

> "When two balls are let fall, two balls at the other end of the line move in response to their action. Newton's third law is usually stated as follows: To every action there is an equal and opposite reaction."

This is, in truth, the usual statement of Newton's third law, but Newton furnished examples making it perfectly clear that by "action" and "reaction" he meant *forces,* not events or occurrences. Two balls falling against a row of balls is an event; it is not an *action* (an *action force*) in Newton's sense of the word. Two balls jumping out at the other end of the row is, again, an event; it is not a *reaction* (a *reaction force*). It is true also that Newton's third law is required to explain the effect, but it is a poor introductory example because *more* than the third law is involved. If the experiment were done with balls of putty, for example, the third law would still apply, but an observer would see quite different behavior on the part of the balls—a behavior not at all useful as an introduction to a simple "action equals reaction" conclusion.

What Newton meant might be stated this way:

> Whenever any A exerts a force on some B, B exerts an equal and opposite force back on A.

It should be noticed that two important facts are stated here—(a) that the two forces (which may be referred to as the "action" and the "reaction" forces) are equal and opposite, and, of equal importance, that (b) there always *are* two forces. There can be no such thing as A exerting a force on B without B exerting an equal and opposite force on A. If B is incapable of exerting a force on A, A can't exert a force on B. You can't *push* against *nothing;* you can push only if you have something to *push against*—something pushing back on you.

Some of the confusion seems to arise from failure to distinguish between "action and reaction" forces, which always act on *different* bodies, and the forces which determine whether or not a given body is "in equilibrium"—these being *only,* and *all,* the forces *exerted on* the particular body in question. Consider some examples of this confusion:

> "If you put your shoulder to a heavy iron gate and try to push it open, you will find that when you push the gate, the gate will push back. Should the gate suddenly give way, you would fall forward on your face because your push on the gate would no longer be opposed by the gate's push against you."

The inference drawn by the student is this: The gate's push is gone; yours is still there, and this is what, now being unopposed, pushes you over on your face. But your push on the gate (even if it *could* exist after the gate's push is gone) couldn't push *you* over on your face. The only forces that

can push *you* over are forces exerted *on you* by something else. While you were pushing on the gate, and the gate was pushing back on you, there must have been other forces acting on you too, keeping you in equilibrium. These were forces exerted on you by other things, probably the gravitational pull of the earth *on you,* and a force exerted *on you* by the ground on which you were standing. These forces, together with the force the gate exerted *on you,* held you in equilibrium. If the gate collapsed, so the force it exerted on you disappeared, it was the *other* forces exerted on you, now not balanced out by the force the gate was exerting, that pushed you over.

> "When a ladder leans against a wall, the ladder and the wall are each in a state of equilibrium—each object, the ladder and the wall, is in its own separate state of equilibrium. If the force of one becomes greater than the force of the other then both objects will move."

Here one finds a not-uncommon expression—"the force of an object"—and what it means is rarely clear. Objects have forces exerted on them; objects themselves exert forces on other things; the only unambiguous way to refer to any of these forces is to include two items of information—what exerts the force, and what "feels" the force. In the introductory sentence quoted above, one is led to believe that the forces being discussed are (a) the force the ladder exerts on the wall, and (b) the force the wall exerts on the ladder. But one of these *cannot be* greater than the other—they are an "action" and "reaction" pair, and they must always be equal in magnitude. In a later sentence in the same paragraph as the one quoted above, one finds:

> "If you push against an object with a force greater than the force with which it pushes against you, then the forces will no longer be in equilibrium—the forces will be *unbalanced forces,* and the object will move in the direction of the larger force."

If the third law is correct, you can't push against an object with a force greater than that with which it pushes against you; these forces must always be equal in magnitude. Whether a state of equilibrium exists for the object against which you push depends on the external forces exerted on that object *by you and by other things,* and depends *not at all* on the force the object exerts on you. The same book says:

> "Without the aid of friction or mechanical advantage it would be impossible for you to move an object which weighed more than you. Your most heroic force on an object would be met with an equal but opposite force of the object on you."

The first statement is utter nonsense; the second is absolutely true as a statement of fact, but it is not an explanation of the first statement. The force that the object exerts *on you* has *nothing* to do with the equilibrium of the object. Whether the object moves depends on the force you exert *on it* and on whatever other forces are exerted *on it.* If there are no other forces exerted on it (or if all the other forces exerted on it have a zero resultant) your most heroic force might give it a whale of an acceleration—your *smallest* force would give it a finite acceleration, and set it in motion.

Counteraction

The action and reaction situation is still further confused by the introduction of another term—"counteraction."

> "If two boys pull upon a light wagon in opposite directions, the wagon moves in the direction of the greater force. Here *two forces* act upon *one body.* This is an example of *counteraction,* in which there is an *unbalanced force. Reaction* is shown by the fact that the earth reacts against the feet of each boy with a force which is exactly equal to the *pull* he exerts."

What introduction of the term "counteraction" contributes to understanding of the situation is not at all clear. No doubt reaction *is* shown by the fact that the earth "reacts" against the feet of each boy, but it should be made clear that the force the earth exerts against each pair of feet is not the "Newton's-Third-Law-reaction-force" to the pull each boy exerts on the wagon. *If* there are no other forces acting on the boy, and *if* the boy pulls on the wagon parallel to the earth's surface, and *if* the boy remains at rest or moves at constant velocity, then it is true that the two forces—the boy's pull on the wagon and the earth's *horizontal* force against that boy's feet—will be equal in magnitude and opposite in direction, but they do not constitute an "action and reaction" pair. The reaction force corresponding to the force with which the *boy pulls on* the *wagon* is the force with which the *wagon pulls* back *on* the *boy.* This is getting pretty close to the old so-called paradox about the horse pulling on the wagon: If the wagon pulls back on the horse just as hard as the horse pulls forward on the wagon, how can the horse move? And of course the answer is that the fact that these two forces are equal has nothing to do with the question about how the horse can move. What determines the motion of the horse is the set of forces acting *on the horse,* and the force that the horse exerts on the wagon is *not one of them.* So long as the force pushing the

horse forward—the force the ground exerts pushing him forward (the reaction force to the force with which he pushes back on the ground)—is equal to the force with which the wagon pulls him backward, he can, once in motion, keep going forward at constant velocity. If, by pushing backward against the ground a little harder, the horse can get the ground to push him forward a little harder, he can get an *acceleration* in the forward direction (assuming that the force with which the wagon pulls backward remains the same).

There seems to be one "favorite" example of action and reaction forces—an example involving a supposed reaction on a hose nozzle due to an emerging water stream. One finds pictures of firemen holding hoses—one in which the fireman is obviously struggling to hang onto the hose, which makes about a 90-degree bend just behind him, and the caption says:

> "This man knows by experience that he must lean forward and brace himself to prevent the backward reaction of the water from knocking him over."

Another book says:

> "A garden hose kicks backward as the water squirts forward. To overcome the reaction of the powerful stream of water issuing from the firehose requires the efforts of several able bodied men."

Certainly if the efforts of several able-bodied men are required, one can't say that there aren't any forces around, and hence one can't say that there aren't any reaction forces around—but the reaction force is not a "backward reaction as the water squirts forward." The fireman's hose is probably a "modernization" of the old Hero's engine example —which was a correct example. The next stage in textbook modernization will be to cite the jet airplane or the rocket (actually the "next stage" has already arrived in some books) and things will be all right again. But the *backward kick* on the water hose just *doesn't exist*. It would if the water were initially at rest within the nozzle, and were set in motion and ejected by some mechanism operating there. Under these conditions there would have to be a forward force producing acceleration of the water, and there would then be a backward force—the force the water exerted on the accelerating agent—which would constitute a "backward reaction" against which the hose-holder would have to fight. This does not say that firemen don't have to hang onto hoses—they certainly do, but it is because of the force the water exerts "sideways" where there are turns and bends in the hose, not because of any backward reaction. The "backward" reaction is back at the pump, water accelerating.

NEWTON'S SECOND LAW OF MOTION—STUDY OF AN ACCELEROMETER AND BATHROOM SCALE

By RICHARD E. HANEY

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THIS IS A REPORT of two laboratory activities for physics classes. In the first, pupils make use of a bathroom scale calibrated in "newtons" to get a sense impression of this absolute unit of force. In the second, they pull or push an "accelerometer" mounted on a wagon to "get the feel" of an unbalanced force producing the uniform acceleration of a vehicle.

Both the concept of the absolute unit of force and the relationship between force, mass and acceleration are outgrowths of Newton's second law of motion. This law, important because it is one of the foundations of mechanics, seems to be difficult for high school pupils to understand and difficult for teachers to present. Authors of textbooks are not in agreement on how it should be approached.[1]

Newton's Second Law and Derived Units of Force and Mass

Newton's second law of motion is of timely interest to physics students because it not only is basic to an understanding of everyday occurrences here on earth but underlies the explanation of the motion of planets and many phenomena of space travel. For students to speculate on these matters with understanding they must not be "earth-bound" in their thinking. The concepts of weight, force, and mass, for instance, will take on new meaning to space travelers. In developing these concepts, sense impressions such as the feel of muscular exertion and the sight of objects in motion are every bit as important as the intellectual activity of applying formulas to solve problems.

Newton's famous second law of motion states that if a body is acted on by an unbalanced force it is accelerated at a rate directly proportional to this force and inversely proportional to the mass of the body. An unbalanced force is the net force in addition to that which is required to counteract friction and any other forces acting on the body. In symbolic form it states that $a \propto f/m$ or $f \propto ma$. This can become the equation $f=ma$ if proper units of force, mass, and acceleration are chosen. Mass refers to the quantity of inertia of a body, while acceleration means rate of change of velocity.

If units of mass and acceleration are defined first then the second law of motion can be used to define units of force. This is how the ***newton*** and ***dyne*** are defined. A force of one newton acting on a mass of one kilogram produces an acceleration of one meter per second per second. A force of one dyne acting on a mass of one gram produces an acceleration of one centimeter per second per second.

The newton and dyne are absolute units of force because they are of the same respective magnitudes everywhere in the universe. They are not defined in terms of the weight of any object. The newton is a unit in the Meter-Kilogram-Second (M.K.S.) system of units and the dyne is a unit in the Centimeter-Gram-Second (C.G.S.) system. These systems are mentioned frequently in physics textbooks.

In addition to these two units, we commonly use the British Engineering System. In this system the pound is defined *a priori* as the magnitude of the earth's gravitational pull on a "one pound mass" at a specific location and is called a "one pound force" or usually just the pound. This unit of force in conjunction with the formula $f=ma$ is then used to define a new unit of mass called the *slug*. A force of one pound acting on a mass of one slug produces an acceleration of one foot per second per second. One slug of matter weighs about 32.2 lb at the surface of the earth.

This report was an entry in the 1957-58 STAR (Science Teacher Achievement Recognition) awards program conducted by NSTA, sponsored by the National Cancer Institute, U. S. Public Health Service.

[1] L. W. Phillips. "On Some Aberrations in Discussions of Newton's Laws of Motion." *The Science Teacher*, 25: 444, December 1958. (See also author's article page 16.)

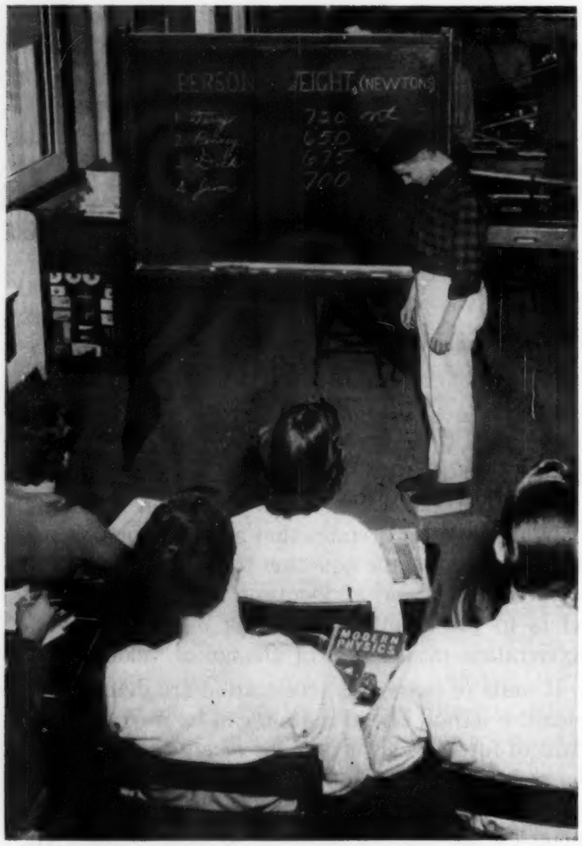


Figure 1

SUMMARY OF UNITS IN THE THREE COMMON SYSTEMS

System	*Force*	*Mass*	*Acceleration*
British Engineering	pound	slug	ft/sec/sec
M.K.S.	newton	kilogram	m/sec/sec
C.G.S.	dyne	gram	cm/sec/sec

The two mechanical devices whose descriptions follow are intended to help pupils acquire a functional concept of the newton, a new term in their vocabulary, and to see more clearly the relationship between force, mass, and acceleration using units of the British Engineering System.

The Bathroom Scale Calibrated in Newtons

Pupils can acquire a feel of the magnitude of a newton without knowing the second law of motion. Most of them do this for the pound without knowing its legal definition. They learn this by lifting common objects such as boxes of candy, sacks of flour, or bar bells whose weight they know or by keeping track of their own weight.

In our physics room there is a bathroom scale which is calibrated in newtons. Everyone in the class had a chance to weigh himself and to find the weight of other objects in newtons. See Fig. 1. This occurred at the beginning of the unit on mechanics. For example, they learned that 100 kilograms of water weigh about 980 newtons.

It is not difficult to calibrate a scale to read in newtons if one remembers that a mass of one kilogram weighs about 2.2 pounds or about 9.8 newtons. This last relationship follows from the second law of motion. When a 1-kg mass falls freely its acceleration is 9.8 m/sec/sec. Therefore the force acting on it (its weight) is 9.8 nt.

On our scale the 360° of the circular dial were divided into 260 lb. which is equivalent to 1158.2 nt. For simplicity a graduation was placed on the new dial every 50 nt. Therefore the angular distance between these marks is

$$\frac{50}{1158.2} \times 360^\circ$$

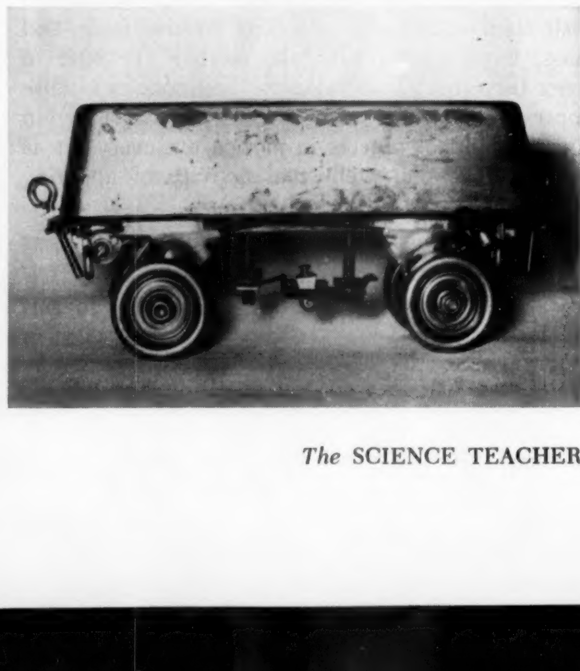
or about 15.5°. These graduations were placed on a circular piece of cardboard which was glued over the original dial.

By the time the newton had been used in problems involving static forces the pupils were ready to understand this term when it was formally defined in the chapter on Newton's laws of motion.

To demonstrate Newton's second law of motion

Figure 2

The weighted car is made from the front ends of two roller skates from which the shoe clamps were removed. In their place are fastened four eye bolts through which two horizontal guide rods pass. The lead weight was made by pouring molten lead into a 9" by 5" aluminum loaf pan. Enough lead was used so that the total weight of the car would be 32.2 lb. Two ¼" bolts were set upright in the lead. These fasten the weight to the skate. A roller contact from a toy train is fastened to the bolt on the right and a wire connected to the bolt on the left grounds it to the car.



a person can pull on a weight to give it an acceleration. Usually this is nothing more than a jerk on a string attached to a hanging weight or weighted car such as a Hall's carriage or roller skate. If the jerk is strong enough the string breaks. However, the continuous uniform acceleration of an object requires the continuous application of an unbalanced force. This is the type of acceleration which is most often dealt with in problems in physics texts. It is the type of acceleration which rockets, trains, or automobiles undergo as they accelerate over a period of specific time. The experiment helps clarify the definition that a, the rate of change of motion, varies directly as f, the force that causes it.

The Accelerometer

The accelerometer is a device in which a force can be applied to a weighted car whose mass is one slug. See Figs. 2 and 3. The car is pulled by a spring scale so that the acting force can be measured. It would be difficult to pull this tiny car for any length of time and read the applied force simultaneously. Therefore the car is mounted on a steel track in a frame so that the whole frame can be pulled on some other vehicle such as a coaster wagon or moved in an automobile. Under these conditions the car has to roll only an inch or two with respect to the frame as it stretches the spring in the scale.

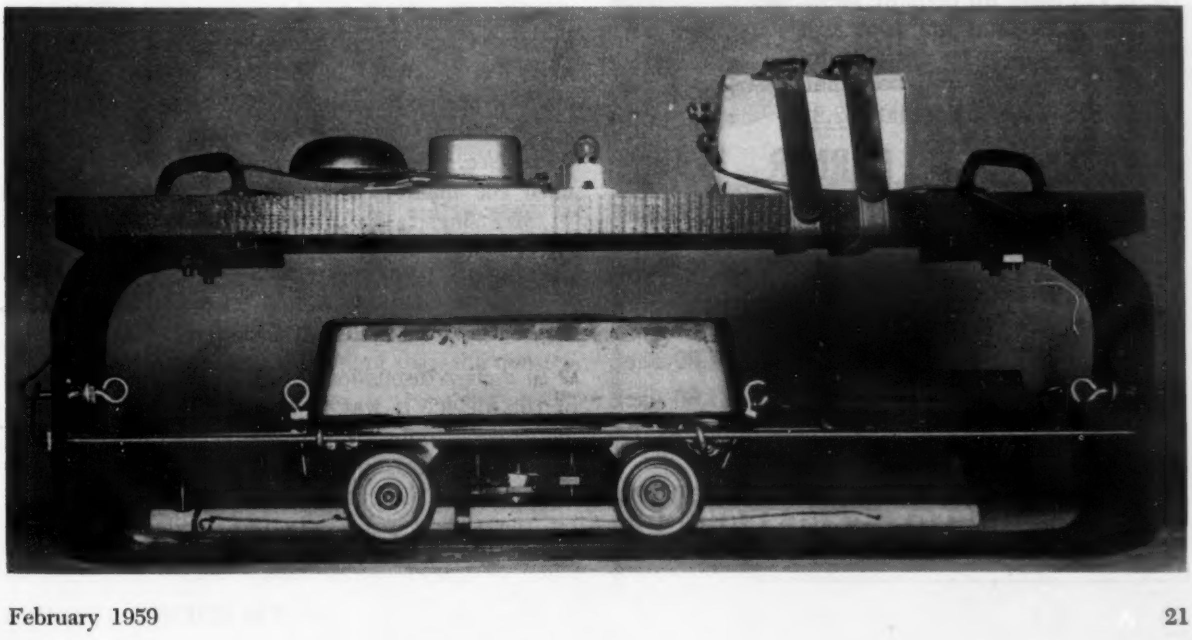
A stationary observer could not read the moving spring scale, however, so the magnitude of the force applied to the car is indicated in another way. Beneath the car there is a roller contact taken from an electric train. As the car tends to roll back along the track during acceleration of the frame (actually the frame tends to pull ahead under the car) the roller moves along an insulated rail until it touches a contact which can be set at any position along the rail. When the roller contact touches the contact on the rail a bell rings indicating to the observer the distance the car has moved back. This distance is an indication of the tension in the spring since the distance a spring is stretched is directly proportional to the force applied to the spring (Hooke's law). In other words, a given force pro-

Figure 3

The Complete Accelerometer is made by using a frame from a piece of cold rolled steel, 5' by 4" by 5/16." The upright ends are 22" apart and 6" high. The bends were made by heating the steel in a forge and hammering them on an anvil. The frame could also be made by welding separate pieces of steel together. Holes for the two 3/16" guide rods were drilled at the same height and distance apart as the eye bolts on the car. They were drilled after the ends were bent. The rods keep the car from slipping sideways on the track. There are two countersunk ¼" holes at each end of the bottom of the frame so that it can be bolted to some vehicle.

The insulated rail consists of a ½" dowel with a binding post attached to one end. The rail is bolted to the center of the steel track at such a height that it does not touch the axles of the skate yet is high enough to be touched by the roller contact on the car. The movable contact is a snug fitting copper ring. Between the ring and the wood dowel there is a bare copper wire connected to the binding post. The wire is always in contact with the ring. The binding post is connected in series with the bell and battery. The other side of the battery is connected to the steel frame which is always in contact with the car. Thus when the roller contact touches the ring the circuit is completed.

The spring scale shown registers up to four pounds but others of different capacities can be substituted depending on what type of experiment is to be performed.



duces exactly the same (additional) stretch, regardless of how much the spring is stretched by other forces. This is providing, of course, the elastic limit is not exceeded.

The contact on the rail can be positioned to ring the bell when the tension is one pound or moved farther back to close the circuit when the scale reads two pounds, etc. If the acceleration is so great that the car moves back beyond the position of the set contact the circuit is again open. Thus if the vehicle on which the accelerometer is mounted is pulled in such a way that the bell rings continuously the force on the car is maintained at a constant value and the weighted car, hence the vehicle on which it is mounted, is being uniformly accelerated.

The one who pulls the wagon and his observers soon discover an interesting fact: *that to apply a constant force to a movable object one must continuously increase his speed.* Many pupils believed that a net force is required to keep an object moving at *constant speed.* It is one thing for pupils to see a little car move along a table as may occur in some demonstration of Newton's second law, and another to see the fastest runner in the class unable to maintain a constant pull of some small value on the accelerometer even though he starts moving slowly.

The accelerometer can also be used to indicate the magnitude of the acceleration of the vehicle on which it is mounted. Since the mass of the little car is one slug it follows from the relationship $f=ma$ that the reading of the spring scale in pounds is equal to the numerical value of the acceleration in ft/sec/sec.

In learning this use of the accelerometer the pupils were led to see the need for inventing the unit of mass called the slug if the pound is to be taken as the fundamental unit of force. If both mass and force were measured in pounds the formula $f=ma$ would have to be altered. When a mass of one pound falls freely a force of one pound acting on it produces an acceleration of 32.2 ft/sec/sec. But this fact does not fit the equation until the mass is changed from "one pound" to "1/32.2 slugs." By removing the car from the accelerometer and lifting it the pupils could see how heavy a slug is.

Class Discussion

In a class discussion concerning the possible uses of this device it was discovered that the accelerometer could only measure the acceleration of vehicles moving horizontally since the only force on the weighted car that can be measured is that applied by the spring scale. If the accelerometer were tipped at some angle on a vehicle headed up or down

Figure 4

The Mounted Accelerometer: The accelerometer can also be mounted in an automobile or pushed in a baby cariage. If the accelerometer were fastened to the bottom of the wagon it would be less visible but the wagon would be less likely to tip. (A light replaced the bell when the experiments were indoors.)

a hill some gravitational force would also tend to cause the car to move along the steel track in the frame. In a vehicle headed down a hill the scale would only indicate a fraction of the total unbalanced force on the car since the component of the weight of the car which is parallel to the inclined steel track would be applied invisibly to every molecule of the car by gravitation rather than by means of the spring scale. Therefore the reading of the scale would indicate a fraction of the numerical value of the acceleration down the incline. Likewise for vehicles accelerating up an incline, the reading of the scale would be more than the numerical value of the acceleration. This is an example of the way in which an instructional device such as this can stimulate discussions among pupils based on the facts which they have learned.

Finally, this device can be used to detect accelerations of a vehicle which are unwanted. In this way it illustrates the fact that for an object to move at constant speed there can be no unbalanced force acting on it, which is Newton's first law of motion. This demonstration can be accomplished by setting the contact on the rail to touch the roller contact when the reading of the spring scale is zero. As a result the bell rings when the accelerometer stands still or moves at constant velocity. (See Fig. 4.)

The modern inertial guidance system of rockets makes a similar use of accelerometers. In this instance they detect any change in the direction or speed of the rocket and transmit signals to mechanisms which can correct for deviations from a predetermined course.

Conclusion

In this age of impending space travel we rely more than ever on the concepts employed by Isaac Newton in the seventeenth century. Yet even now pupils entering the twelfth grade are unfamiliar with such terms as slug, dyne, and newton which are the "tools" needed to understand the laws governing moving objects. It has been suggested in this report that to learn these concepts the pupils must use their muscles as well as their minds and to do this they need gadgets. Perhaps the mechanical devices which have been described will be a stimulus for further "gadgeteering"—which, after all, is half the fun of teaching and learning physics.

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The National Science Teachers Association

announces a new program of

Science Teacher Achievement Recognition Awards

STAR '60

Purposes. STAR '60 is designed to stimulate and to recognize superior science instruction in grades 7 through 12 in public, private, and parochial schools of the United States. STAR '60 is planned to encourage the development of creative ideas, teaching materials, and teaching techniques, and to secure the widest possible dissemination of such, for the purposes of:

1. Raising the general level of science instruction
2. Influencing more young people to enter the fields of science and science teaching
3. Helping young people to understand that the key to our science problems is more and better basic research
4. Developing understanding that many fundamental science problems (such as the control of cancer) require the cooperative attack of specialists in fields as diverse as physics, botany, chemistry, physiology, mathematics, genetics, and bacteriology
5. Developing a thorough understanding of the basic principles of biological and physical science and their application to such fields as health through presently established courses
6. Developing reflective and critical thought habits.
7. Helping young people gain skill in scientific problem solving

Sponsors. STAR '60 is supported by a grant to the National Science Teachers Association from the National Cancer Institute, U. S. Public Health Service. The National Cancer Institute has made this grant because it appreciates the importance of the science teacher in developing a pool of young scientists from which may be recruited future leaders in research, the teaching of science, and other scientific professions.

Nature of entries. The following illustrate types of activities, reports of which are suitable for submission to STAR '60.

1. Teacher demonstration
2. Laboratory exercise
3. Curriculum construction or revision
4. Extra-curricular or co-curricular activity
5. Teacher or pupil projects
6. Science teaching methods
7. Research in science or science education
8. Educational program planned and executed jointly by a school and a local community health agency

The sponsors of STAR '60 will welcome the collaboration of science teachers and practicing scientists in the development of joint entries. Medallions will be awarded to teacher and scientist if cash award is won.

Judging criteria. Entries will be judged on the basis of resourcefulness in terms of ingenuity; the most effective use of available facilities; creativeness; completeness in concept and presentation; accuracy; and utility for application in other teaching situations.

Recognition.

1st Award	$1000
2nd through 11th Awards (10)	500 each
12th through 31st Awards (20)	250 each
32nd through 56th Awards (25)	100 each

Certificates of Merit—for entries in honorable mention category

Certificates of Participation—to all entrants

Medallions will be awarded to all winners of cash awards.

Plaques will be presented to schools represented by winners of cash awards.

Medallions will also be awarded to scientists who participate in cash-award winning entries as collaborators.

An announcement-application circular concerning STAR '60 will be mailed early this Spring to all NSTA members and other science teachers throughout the nation. The circular will give further information about STAR '60, and will describe procedures for those who wish to participate in the program.

The closing date for the receipt of entries for STAR '60 is December 15, 1959. The announcement and presentation of awards will be featured at the 8th National Convention of NSTA in Kansas City, Missouri, March 29-April 2, 1960.

Selected winning entries will be published in a STAR '60 brochure which will be distributed during the late summer of 1960.

Viewpoint on a Basic Problem in Elementary School Science

By ALPHORETTA FISH

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MANY OF TODAY'S elementary-school teachers face a psychological conflict when they are confronted with the task of teaching science to young children. The teacher wants desperately to accept the educational philosophy that science at the elementary-school level has an important contribution to make to the young child's developmental needs. Yet, as a teacher, she tends to teach as she was taught. Never having had science in the elementary-grades, today's teacher cannot "see" herself as a young child learning science. She cannot "see" herself as a young child thrilled or enlightened by a classroom science experience. Nor can she recall any security, understanding, or independence such experiences provided her. And so, an unresolved conflict exists between a desire to accept the knowledge of the experts and a reluctance to teach a subject to which the *teacher* cannot relate realistically.

It is true that the elementary-school teacher has been expending more effort on the teaching of science since the advent of Sputnik; but this effort has not been expended because the teacher has "seen" relationship between science experiences and the child's day to day, here and now, developmental needs, but because the teacher knows that with the new emphasis on science the child's success and/or freedom from frustration when he enters college may depend upon her efforts at the elementary-school level. She knows, too, that the child is living in a world where, as an adult, scientific "know-how" may be the *key* to his success and possibly to his survival. Yes, today's elementary-school teacher has accepted the fact that science teaching is important and that, because it is important, it must be taught. All of this is very real to today's teacher, but she still does not "see" how the subject-matter of science meets the child's developmental needs.

Let me illustrate, briefly, how having learned to "read" at the elementary-school level is related to how a teacher *feels* about teaching reading to young children. Of utmost importance, of course, is the fact that she can recall a preponderance of "satisfactions" associated with learning to read. She "sees" the pattern of her own reading interests; and she "sees" the developmental sequence of these interests in relation to the "felt" needs of her own childhood. The most significant factor involved here is that the teacher responds to her recollections emotionally. If the emotion is positive she *feels good* about providing similar experiences for another child; whereas, if the emotion is in part negative, she *feels good* about avoiding those experiences which would cause another child to have similar negative reactions toward reading. In any event, when the teacher is exposed to educational philosophy which emphasizes that a relationship exists between the teaching of reading and the child's developmental needs, she responds meaningfully by teaching in such a way as to provide for these needs. As Combs[1] has suggested, "Seeing is behaving!"

Unfortunately, the emotional reactions awakened as today's elementary-school teacher recalls her experiences in learning science at the high-school and college levels tend to be more negative than positive in many respects. Perhaps, in memory, we can "go back" to the day we had our first *real* experience with a microscope. The assignment was to locate and make a drawing of a paramecium. Fifteen minutes remained of the period and the clamoring of the three other students assigned to the same microscope for the same purpose created real feelings of frustration. The simplest solution to this dilemma was to copy a paramecium from a picture in the textbook, but guilt feelings often resulted from resort-

[1] Arthur W. Combs. "Seeing Is Behaving." *Educational Leadership*, 16:21-26. October 1958.

ing to such solutions. Equally poignant are the emotions associated with one's complete inability to comprehend some of the concepts which were presented and those associated with the necessity for devising "fool-proof" techniques for assisting the mind to recall volumes of unrelated data. Keep in mind that the teacher of today approached these experiences as a student untrained in the "skills of scientific thinking" and lacking in the experience of handling the equipment and materials used in the science classrooms. The memory of hard work and the unanswered question, "For what?" makes this picture complete. Is it any wonder, then, that when a teacher is exposed to educational philosophy which emphasizes that a relationship exists between the teaching of science and the child's developmental needs she can only "hope that this is true," and can do very little about incorporating this philosophy into her teaching of science.

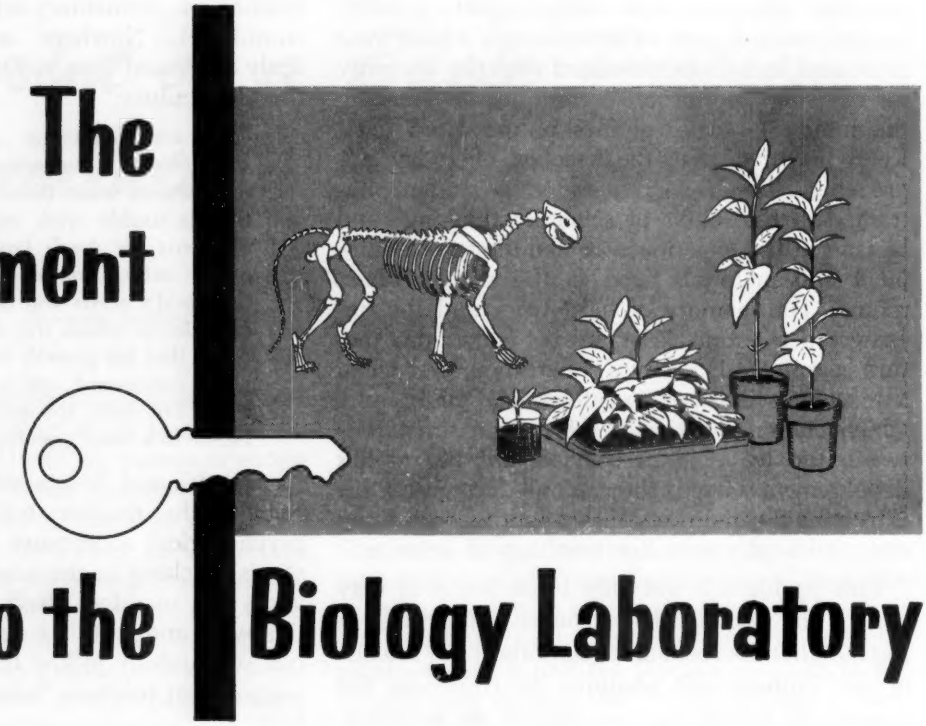
This problem is not only basic but it is very real to the conscientious teacher. Hope lies in the fact that the recognized importance of science in our culture will continue to challenge the experts to insure the success of its teaching. However, if science teaching is to have the drive of a real goal behind it, the needs peculiar to the teacher of elementary-school science must be considered. Nowhere are these needs more aptly expressed than in Dewey's,[2] *The Child and the Curriculum*:

> ". . . what concerns . . . [the teacher] is the ways in which the subject may become a part of experience; what there is in the child's present that is usable with reference to it: how such elements are used; how his own knowledge of of the subject-matter may assist in interpreting the child's needs and doings, and determine the medium in which the child should be placed in order that his growth may be properly directed. He is concerned, not with the subject-matter as such, but with the subject-matter as a related factor in a total growing experience."

As "needs" and "relationships" are clarified and refined, the teacher will increasingly gain a psychological acceptance of the worth of what she is teaching in the science program. Acceptance will manifest itself in behavior. It is in this way, and in this way only, that the teacher can successfully follow the advice of those who suggest that teachers "learn with the children."

[2] John Dewey. *The Child and the Curriculum*. Chicago: The University of Chicago Press. 1902. p. 23.

The Assignment —KEY to the Biology Laboratory



By PAUL KAHN,

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Science teachers are very much concerned with the assignment as an important adjunct to the classroom and the laboratory. Within experience, those of us who will may recall the necessity for doing an assignment prior to or following the laboratory to make the latter more meaningful. This paper embodies the plea that the home assignment be made an integral part of the biology laboratory on a widespread basis. Plan the assignment as a segment of the laboratory exercise and, if possible, include it in every one.

To espouse such a cause seems to be contrary to whatever experimental evidence is available on the subject. Researchers at the elementary and secondary school levels show little relationship between homework time and pupil progress, achievement or success; any benefits derived are more than counter-balanced by the disadvantages in terms of attitudes, health, and the like. Monroe[1] sums up: Generally speaking, the evidence and opinion of educators are against homework, at least of the conventional kind. The trend of thought is in the direction of letting such homework as is to be done be of the optional or recreational type." Inevitably, the result among educators in the last half century has been to reduce, modify, or even do away with the homework assignment, although an ever more vocal group, including parents particularly, has not been altogether in agreement.

Conforming, albeit tacitly, to research thinking, science education textbook writers of recent vintage (Burnett, Richardson) have failed to so much as list home assignments either in their tables of contents or indices. Perhaps the authors feel that the more inclusive term "directed study," indexed and dealt with briefly in one text, should suffice. Yet no such reticence prevails with respect to the laboratory. To quote Richardson[2], "Many are convinced that the laboratory, in

[1] Walter S. Monroe. *Encyclopedia of Educational Research.* New York: Macmillan, 1952. p. 381.

[2] John S. Richardson. *Science Teacher in the Secondary School.* Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1957. p. 70.

the broad sense, is the heart of the educative process." A source of problems as well as solutions, the laboratory is said to promote student understanding of the scientists' role in our society and to contribute to the development of skills, habits and attitudes.

Homework Assignments

On the other hand, at, or near, the core of the Soviet educative process one seems to find, strangely enough, the homework assignment. In fact, a defect of Russian education is said to be the giving of excess home assignments with their subsequent regurgitation in class—an interesting point when viewed in the light of the "Brothers Sputnik." However, even in America it can scarcely be contended that home study and assignments do not contribute materially toward scientific learnings. But whatever the merits of the case for or against homework as an arm of the classroom, proper assignments can contribute effectively toward the laboratory as the "heart" of science education:

> They may give rise to student problems to be solved in the laboratory.
>
> Proper assignments may make laboratory problems more meaningful in terms of the students' life and experiences.
>
> Materials, not ordinarily available, may be provided the school by the home.
>
> Proper assignments may give the student practice in laboratory procedures, where such practice time cannot be found in the crowded school day.
>
> They may provide for greater individualization of laboratory instruction.
>
> Excellent assignments can teach effectively the scientific method and attitudes.
>
> Inspiration and ideas for individual and group projects may derive from well-devised home assignments.

Toward these goals in biology the author has found three types of laboratory assignments worthy of trial. In the first instance, the preparation and cultivation of living things has given rise to ideas, materials, and problems. Students have provided "homes" for "stray" protozoa, molds, yeasts, bacteria, and Drosophila, having been given starter cultures, mold inhibitors, nutrient agar, and plastic petri dishes at cost. A second type of assignment ideally adapted to individual needs adds practice time to a technique learned in the laboratory. At the request of pupils, and after purchase at cost, chromatographic paper was issued for trial purposes on colored materials at home. Lastly, assignments were devised for youngsters to report to school on laboratory days with materials prepared at home for use in connection with problems to be pursued in school. In this category were assignments to prepare potatoes cooked in various ways (boiled, fried, broiled, and baked); to bring in different kinds of fruit juices; and to take specimens of urine correctly.

This report was an entry in the 1957-58 STAR (Science Teacher Achievement Recognition) awards program conducted by NSTA, sponsored by the National Cancer Institute, U. S. Public Health Service.

It may serve to clarify matters somewhat to describe how the assignment was used by the writer as an adjunct to a problem-solving laboratory in biology. In our school where biology classes meet six times weekly, two of the periods are placed together to provide an uninterrupted double laboratory period. Assignments were made the week previous for the following laboratory and reminders were given at intervals during the week so that the assignment might not be neglected and so that sufficient time might be spent on it. With the detailed description which follows, given as a series of topics, assignments and laboratory problems, it might be emphasized that the plan covered only one semester of biology and that, merely on an experimental basis for the period September 1957 to January 1958.

A. *TOPIC:* The Compound Microscope

ASSIGNMENT:

1. Make a permanent slide (materials at cost) of some small, thin object you would like to see under the microscope. (Suggest use of a printed letter, fly wing, feather, fiber, or the like. For gifted students it is best not to demonstrate the procedure.)
2. Take your own microscope to the laboratory, if you wish.
3. For cleaning purposes, have with you at the next laboratory paper towelling, lens tissue, plastic sponge, and lysol solution.

LABORATORY PROBLEMS:

1. To learn how to properly use and care for the compound microscope with the aid of the homemade slide. (The student should be encouraged to evaluate his mount and learn how to correct his errors.)

2. To learn and practice the rules for cleanliness in the laboratory using materials from home.
3. To start a log or notebook for all laboratory problems which will be inspected at intervals.

B. *TOPIC:* Cells

ASSIGNMENT:

1. Cut several very thin slices of cork; have them with you at the next laboratory period.
2. Prepare the thinnest possible section of onion epidermal tissue and mount it temporarily on a slide with a drop of iodine solution. (Successful students should demonstrate the technique at the next laboratory period.)
3. Read the account of Hooke's discovery of cells in your textbook.

LABORATORY PROBLEMS:

1. To repeat and evaluate Hooke's experiment, using materials prepared at home.
2. To determine the distinguishing features of living as compared with non-living plant cells.
3. To discover plant and animal cell differences.

C. *TOPIC:* Protozoa

ASSIGNMENT:

1. Pick up from the laboratory a small amount of paramecium culture in your own vial or bottle.
2. Set up several sub-cultures at home using at least three different media. (Suggest oats, rice, egg, etc.)

LABORATORY PROBLEMS:

1. To determine structural and functional characteristics of paramecium.
2. Using laboratory equipment, to compare the effectiveness of the media used to grow paramecia at home.
3. To learn how to isolate a single paramecium for growth of pure cultures.

D. *TOPIC:* Algae

ASSIGNMENT:

1. Prepare a culture of algae from material found in your home aquarium or that provided by the school laboratory.
2. Arrange an experiment, with proper controls, to test the effect of light, temperature, or salts on photosynthesis or growth of the algae.

LABORATORY PROBLEMS:

1. With the aid of microscope and chemicals (alcohol, iodine, etc.) to observe and formulate conclusions from the home experiments.
2. To study the structure and functions of the algae available.

E. *TOPIC:* Fungi

ASSIGNMENT:

1. Grow bread mold and yeast in wide-mouth jars at home.
2. Do an experiment to find the effect of mold repellents, such as mycoban, moldex or sodium proprionate.

LABORATORY PROBLEMS:

1. Using laboratory materials to observe and formulate conclusions from the home experiments.
2. To determine the structure and functions of the fungi brought from home.

F. *TOPIC:* Photosynthesis

ASSIGNMENT:

1. Start the growth of several radish seedlings in a home pocket garden.
2. If possible, have a water plant such as Cabomba or Elodea with you to laboratory next week.

LABORATORY PROBLEMS:

1. To study the structure of the root hairs of radish seedlings.
2. With brom thymol blue as an indicator to show that carbon dioxide is used during photosynthesis.
3. Having shown that starch is a product of plant metabolism, to find out now whether or not sugar is produced in a photosynthesizing plant.
4. To demonstrate the pigments present in a green plant by chromatographic methods.

G. *TOPIC:* Dissection of the frog

ASSIGNMENT:

1. Test a variety of pigmented liquids at home with chromatographic paper and alcohol as a solvent.
2. Have money and a container with you next week if you wish to purchase a frog for home dissection.

LABORATORY PROBLEMS:

1. To study the internal and external morphology of the frog.
2. To examine heart and nerve-muscle reactions.
3. To observe microscopically frog tissues.

H. *TOPIC:* Nutrients

ASSIGNMENT:

1. Take with you for the next laboratory period foods rich in protein, fat, starch, sugar, water and minerals.
2. Also have samples of several different fruit juices.

LABORATORY PROBLEMS:

1. To find out what nutrient *other* than the major ones are present in the foods available.
2. To compare the vitamin C content of the various juices.

I. *TOPIC:* Digestion

ASSIGNMENT:

1. Have with you potatoes prepared raw, boiled, fried and baked.
2. Samples of milk and a fatty food will also be required.

LABORATORY PROBLEMS:

1. To find out what type of cooking makes potatoes most digestible.
2. To study emulsification of fats and coagulation of milk.

J. *TOPIC:* Circulation

ASSIGNMENT:

1. If possible, obtain a goldfish, beef heart, fresh clam, or chick eggs at various stages of development.
2. Medical equipment brought in would be very helpful: blood typing serum, stethoscopes, sphygmomanometers, and whole blood.
3. Four inch lengths of capillary tubing may be made in the laboratory preparation room prior to next period.

LABORATORY PROBLEMS:

1. To study the structure and functions of parts of the circulatory system.
2. To determine the composition of whole blood.
3. To study some of the characteristics of your own blood.

K. *TOPIC:* Excretion

ASSIGNMENT:

1. Obtain, if possible, a goldfish.
2. Collect properly a specimen of your own urine in a wide-mouth jar.
3. Have a medicine dropper with you next week.

LABORATORY PROBLEMS:

1. To examine the kidney tubules of a goldfish.
2. To note the physical appearance and reaction of normal urine.
3. To test for and determine the normal chemical constituents of urine (organic and inorganic).

In an obviously inadequate effort at evaluation by questionnaire, not a solitary student voice was raised in opposition to the home assignment associated with the laboratory. In fact, the youngsters went far beyond the values ascribed by the writer, listing such achievements as:

gives something interesting to do at home
shows the practical application of knowledge
produces greater interest in laboratory work
builds up a spirit of responsibility
provides opportunities to work on one's own
increases knowledge in an exciting and fascinating manner
helps assure the success of the laboratory and evaluate it
stimulates curiosity about everyday things, brings questions to mind, and provides opportunities to try things out
makes possible the learning of biology first-hand, making it more meaningful and alive
shows how to use simple home materials for laboratory experiments
saves the school time and money—very efficient

Conclusion

The spirit of their almost unanimous enthusiasm may perhaps be communicated through the avenue of a few quotations:

> I think it is a good idea to have us bring in various things for our laboratory periods. Just thinking about the curious items we had to bring made me wonder what we were going to do next. This interest built up until I wanted to do the experiments very much. If I just came in and found some equipment ready for me, I wouldn't be half so interested.
>
> I found the homework for laboratory very fascinating. Bringing biology into my home somehow made the subject more meaningful and alive. I guess a good example of this would be the time we grew different types of fungi at home. Really, I got a terrific kick out of seeing these things grow.
>
> I think it was a good idea because it gave us all a chance to learn biology at first hand, and not just out of a book. The examinations of various foods, blood, and urine were exciting, interesting, and gave valuable knowledge on practical home health. The idea of using materials prepared by you is much more exciting than using those out of a laboratory bottle.

A final word of caution: flexibility must govern the requirement of the assignments described. Some parents may object to having unsightly cultures grown at home; others may not possess appropriate materials or equipment. But with proper motivation and the judicious exercising of options in individual cases only a scattering of delinquent homework will present itself. And the rewards? Perhaps only the wide-eyed wonder expressed by the boy who said, "It has shown me how many experiments can be done with nothing more complicated than household apparatus."

Does Your Fair Pay Its Fare?

By HAROLD E. TANNENBAUM

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EDITOR'S NOTE: This is the second in a series of articles prepared by Dr. Tannenbaum in cooperation with NSTA's Business-Industry Section. Assistance to teachers in their efforts with students is a prime target of B-I-education relations at local, regional, and national levels. This series of articles is intended to focus attention on issues and problems, as well as opportunities, involved in effective collaboration.

THERE have been hundreds of science fairs over the country during the past few years. Some have been excellent, some have been a waste of time, effort, and money. In most of them, however, business and industry have been helpful. Local businesses have given assistance for the fair programs from providing materials and space to providing judges and prizes. The schools and teachers also have done their part. The efforts that have gone into setting up fairs—from inadequately prepared ones to the better ones—have been tremendous. With so much effort, there should be more success. What makes a good science fair?

Purposes of Fairs

Fundamentally, fairs have two purposes. First, the basic function of a fair is to inspire young people to do some creative thinking in the natural sciences. These young people should be encouraged to take basic principles from the various areas of science in which they are interested and, using these principles, create exhibits which show their meaning, ramifications, and applications. Science is a creative activity and, generally speaking, the exhibits should demonstrate this creativity—not primarily elaborateness, or symmetry of design, or elegance of exterior, but creative thought and creative application.

In the second place, fairs should offer students a chance for recognition—recognition by their peers, their teachers, and the people of the community. But this recognition is truly a secondary goal of the fair, and no one knows better than the students when the recognition they receive is deserved and when it is underserved. If rewards in the form of a five-dollar camera or a twenty-five dollar savings bond become the sole purpose of a fair, then the fair soon loses its worth as a science experience. Creating a good science fair can be one of the most important activities in the teaching of science. Holding a poor one can do great harm.

A science fair and its consequent activities are, of course, only one phase of the effort to build creative thinking in the science program. But there are many things that can be done in relation to such activities that are worth the effort; and both the schools and industry can contribute to making them creative. First, there are the projects themselves. A project for a fair is usually produced either by an individual or by a small group. The young people need help with ideas. The ideas may come from classwork, or they may come from science club projects, or from interests which develop out of school. For a number of our gifted young people, this help is not necessary. After all, that is part of their giftedness. They have established interests. They recognize problems. They can and do work by themselves. But for those young people who are not able to find simple but creative projects easily, part of the fair program should be to help them find such suitable projects.

Preparation of Entries

The real work in science fairs, however, comes in relation to the preparation of the exhibits. It is here that most of the teaching and most of the learning take place. And it is here where industry can be of most service to the school and to the students. Since the work of a scientist in business or industry is a continuous round of problem solving, the worth of a few minutes spent helping a youngster find and define his problem cannot be measured. Several industries already have taken on some of this work. For example, one company sent an interested member

of a research staff to spend a day at school and to work with the children individually and in small groups. He went over their plans with them and gave suggestions of some additional readings, a hint of organization, and other suggestions. Of course, he did not tell the young people how to proceed. That would not be helpful teaching nor would it be of fundamental direction to the children. But he helped them clarify their aims and plans.

Another plant sent one of its top men to speak to a group and explain how that industry plans its own exhibits. The stress was placed on two things: finding the problem to be examined and finding a way of describing the solutions so that they become understandable to all who view the exhibit. Good exhibition techniques were discussed at great length. These are examples of possible assistance that industrial scientists can offer participants in science fairs.

Industry's Assistance

Of course, supplies are often a problem for the young people who want to work on science fair projects. Here is another area where industry has given much aid. Many industries have turned over surplus stocks of electronics parts and other science materials to schools for use by the students in their science fair projects. Certainly, a few dollars provided beforehand for materials and supplies to build the projects are often more welcome to the students than are the same number of dollars put into a prize. Another service that some industries have rendered is to allow a few students the special privilege of working with some of the industry's tools under the supervision of the science personnel.

There have been other important cooperative activities of a similar nature. Some industries have instituted summer research apprenticeships. Young people of promise have been given simple science jobs in industrial laboratories around the country. Incidently, it is interesting to note that when such positions have been awarded as prizes at science fairs, they have been the most valuable an sought-after prizes. For most young people, the challenge of science work, when it is related to real problems, is much more important than any other prize that a fair can offer. Such apprenticeships have much promise, but there are a few things that must be avoided. In the first place, we must not expect too much of the young people. They cannot produce at the same level as adults and there is much they need to learn from the staff. Furthermore, they should not be exploited financially or in any other way. It is important that they should have more than just such menial tasks as bottle washing. When they are given specific, simple (and even more complex) tasks and problems, it is surprising how well and with what enthusiasm they work.

But, coming back to the fairs, besides the need for assistance in planning and executing the individual and group projects, the fairs themselves need organization. Some fairs have been quite successful when they have been built around a central theme. For example, one very fine fair was built around an examination of the local county and man's way of life in it. The young people built models of the mines, land and geology models, models of the factories, exhibits of some of the social and industrial problems, and developed suggested plans for solving a traffic problem in the area. The prize winner for that fair was a suggested program for eliminating water pollution at one of the local beaches. Another rather common orientation theme for fairs is a demonstration and explanation of hobbies involving science. This kind of theme has proved successful when the criteria for evaluating the exhibit have been made clear in advance to the participants. When the purpose has been to have all the viewers share in the hobbies of the participants and when everyone has known this, then the exhibit has tended to be more successful.

Recognition and Awards

One of the biggest contributions that industry and business can make at these fairs is in the area of recognition of the work of the children by the people of the community, Too often, the awards have been nothing more than publicity gimmicks of the store or factory that gave them. This, unfortunately, has given fairs a bad reputation. A group of men work hard, and spend money and time on building a fair. Then, someone comes along and awards a baseball glove for a prize and walks off with the glory. Science fairs must not be used for advertising the wares or "the noble citizenship" of any one industry. If a youngster, however, is recognized for his work by men of standing in the community, if a "real, honest-to-goodness scientist" comes up to a thirteen-year-old and discusses his project with him, if he is praised for worthwhile work and helped to see how he could make it better, if he is invited to a laboratory to see how professionals work on similar problems, then he has

received the kind of recognition that he wants. Not only does he gain status in the eyes of his peers, but, much more important, he gains status in his own eyes. These awards need to be given in such a way as to build up the self-esteem of both the winners and the losers. This means a different kind of award system. The awards themselves need to be of a kind that lead on to further work of a creative nature, for example, a chance to work in a science laboratory, or the gift of a piece of special equipment which fits into the work that the student is doing.

Local science fairs may provide an avenue to larger forms of recognition for students. Investigative or problem-solving type projects may be

Hints for B-I Science Fair Cooperators

1. Your most important job is to help teachers and students put on a creative science exhibit. It takes more than a couple of prizes to do this. You need to contribute your time so that your "know how" can be of assistance to the students.

2. Those things which you are going to throw out—those old radio tubes, or those test tubes, or that scrap of plastic, or that out-of-date photographic paper—may be the very things which can be used by the science club for supplies in building projects. Call up your high school teacher and see if he can use them.

3. When youngsters come to call for advice on their projects, don't take over. What they want and need is a chance to try out ideas on you. Remember, they are producing the projects, not you. A good rule to follow is to keep asking them leading questions rather than telling them answers.

4. If you are involved in providing prizes, try to make the prizes appropriate to the work that the students are carrying on. Remember, a chance to work in a "real" laboratory is probably more exciting and worth-while for a youngster than a stamp album or a cheap camera. The prize should lead the student on to further work in science.

5. Science fairs are only one way in which you can help with the production of creative scientists and interested, science-conscious citizens. Taking young people into your plant as apprentices to participate in some of your work can also develop their science creativity.

6. Do give the youngsters a pat on the back when they deserve it. They will appreciate it—and so will you.

reported in the Science Achievement Awards program of NSTA's Future Scientists of America Foundation. In 1958, nearly 4000 students submitted entries in this program and about half were given awards and other forms of recognition. Many science fair exhibits find their way into regional and state fairs, and, ultimately, into the National Science Fair.

Finally

Putting science fairs into proper perspective means that we recognize them for what they can do and for what they cannot do. A "scientist" by definition is "One who is versed in or devoted to science." Such devoted men are needed by the nation, by the schools, and by industry. To get such devotion means that the young people, all of them, must have a chance to work on real science problems and to see how these problems are related to man's well-being. Schools and industry are concerned with making scientists—not science fairs.

Hints for Teachers

1. The ideas that your students carry out for their fair projects are far more important than the elegance of the finished products which they exhibit. Help them find good ideas and help them find ways of solving their problems.

2. Using business and industry personnel to make your science fair better is a wise move. But remember that these men are very busy and should be called on only for those things which you cannot do yourself.

3. Business and industry personnel are continually involved in problem solving. Get your friends from B-I to help your students learn how to solve problems by showing how they do research and test their hypotheses.

4. Know what each individual is doing so that you can help him find the appropriate experts for his needs. Both the students and the experts will enjoy working together if they have common interests and common problems.

5. When you ask people to come and help with your fair, make sure that you clearly explain the job that you wish done. And do make it a job worthy of scientist and teacher.

6. Remember that the real function of a science fair is to help the students become more and more interested and active in creative science. Help your friends from B-I see this. But, most of all, help your students see this.

THINKING SMALL

The National Foundation, New York City

THE unit of measurement used by some scientists, called an *Angstrom,* is one 100-millionth of a centimeter long. String a dozen or so atoms together and from end to end they will measure one Angstrom.

That is small. Thinking in Angstroms is what is meant by "thinking small."

And thinking *Angstrom-small* is intimately involved in some of the most exciting things going on in medical scientific research today.

What is exciting about it? Well, take nucleic acid. Nucleic acid is a chemical substance at the heart and core of every living cell. Scientists have determined that it is the dictator of cell activity, the chemical brain in which is encoded combinations of hereditary factors, the absolute monarch of the physics ad chemistry of life.

And these scientists can tell that a nucleic acid molecule is about 20 Angstroms thick and up to 30,000 Angstroms long. In general, they are able to describe its structure, atom by atom, bond by bond. What can not be told about it, they are doing their best to get the answers, and they have devised some very promising techniques for dealing with it. They are quite literally and seriously "flirting" with the processes of creation, the very secrets of life. What all this may mean to us some day leads to amazing conjecture.

Work of this kind—investigations of basic living cell processes—is being carried on in general by scientists all over the world . . . and in particular by top American scientists supported, with March of Dimes funds, by The National Foundation (originally the National Foundation for Infantile Paralysis). In a new and greatly expanded health program recently undertaken by The National Foundation, these studies are only a part, but a part with tremendous potential for progress in health and medicine science.

In this article, we are chiefly concerned with the broader aspects of The National Foundation's basic research program—with what we have chosen to call "thinking small"—and with the implications for advances that could have a profound effect on the welfare of all humanity.

In medical science, there is great emphasis today on research in genetics. The 1958 Nobel awards in medicine went to three American scientists for their work in genetics. Basic studies of how cells govern their activities and their growth into succeeding generations are just about as basic as one can get.

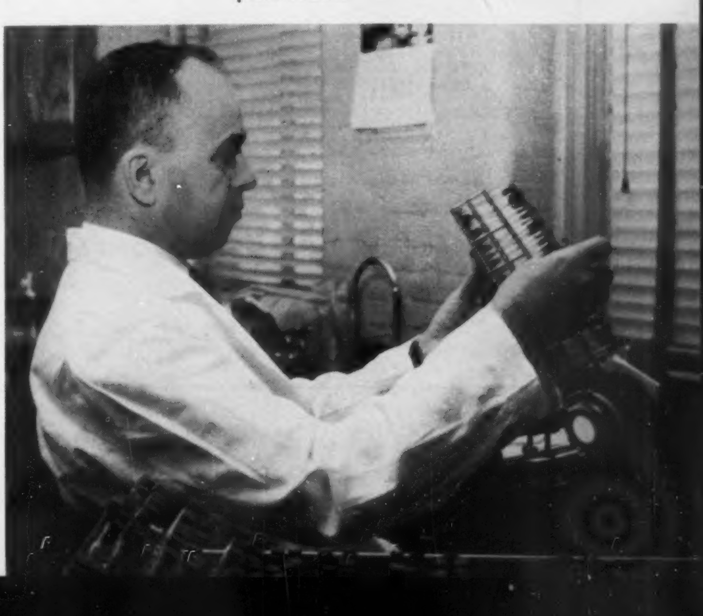
There is a growing conviction among biochemists that years of concentrated study of nuclear protein, although enormously useful, has been slightly off the mark. If you are trying to learn about the final chemical authority in life, they now think, you must investigate nucleic acid.

Every high school biology student studying heredity learns about chromosomes and genes. How many learn that chromosomes have three main chemical components, protein and two kinds of nucleic acid: desoxyribonucleic acid (DNA for short) and ribonucleic acid (RNA)? Do they learn that a gene is essentially a bundle of DNA molecules? Do they learn that RNA is primarily responsible for protein synthesis in the cell and that DNA is responsible for heredity?

Loosely speaking, in structure a DNA molecule consists of two chains of bonded atoms wound helical-fashion around a common axis. The arrangement of the atoms, open to infinite variation, is believed to be the determining factor in making DNA hereditarily specific. Theoretically, if we could learn what influences that arrangement, and *how* to influence it experimentally, we could —well, take it up with your own imagination.

In this age of alphabetical abbreviations, DNA and RNA are creeping into the lay vocabulary. If any prediction in this research field can be

Dr. David Bodian examines cultures of living cells in his laboratory at Johns Hopkins University. Dr. Bodian, whose work is supported by the March of Dimes, is international authority on polio viruses.



made safely, it is that these terms in the immediate years to come will gain increasing significance for us all and will come to be understood and talked about by a great many of us.

March of Dimes grantees came logically to this area of scientific investigations. To study polio, they had to study viruses in general. To study viruses, they had to study cells in general . . . because a virus is but an inert particle of matter until it invades a cell. Only within cells can it feed and reproduce. So virus study led to basic study of cells.

Today, recipients of March of Dimes research grants are studying both cells and viruses. In fact, they are using viruses as tools to learn about cells. A virus consists of a core of nucleic acid (some viruses have DNA, some RNA) surrounded by a jacket of protein. Apparently, the way a virus attacks a cell is by attaching itself to the cell wall and by some process not understood yet, getting its nucleic acid into the cell. (However, it is known that bacteriophage accomplishes this by squirting nucleic acid into bacterium through its tail.) The host cell is then altered or destroyed because the virus nucleic acid takes over control from the cell's nucleic acid and directs the cell to make more virus.

Obviously, these basic cell studies could lead to understanding and solution of some birth-defect problems. Many birth defects are caused by some defect in the nucleic acid of the germ cells from which the baby develops. And, because in effect all disease is essentially a matter of sick cells, it is equally obvious that broadened National Foundation research on cells could contribute to new understanding of man's ailments.

Here is a provocative example. Dr. Salk and other scientists have witnessed a curious thing happen in their laboratories. While maintaining continuous cell lines in test tube tissue cultures, they observed an unexpected change taking place. The cells, originally normal and healthy, after a time became abnormal. Why? What happened? The researchers do not yet have the answer. But it is a tantalizing clue that relates to the problems of cancer. Naturally, it is being investigated by many scientists, including March of Dimes grantees.

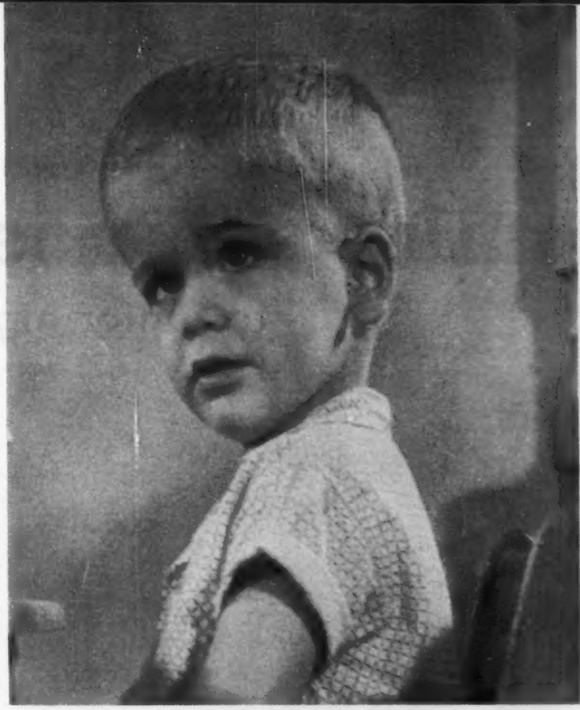
In all likelihood, as you read this article you are harboring one or more viruses of some kind . . . and probably getting along peacefully with them. But viruses are so much in and around us all the time that they cause us a great deal of trouble. Smallpox and yellow fever, both virus

diseases, are under control. Polio is bending to control. Measles and mumps and the common cold are not usually serious. But we are plagued generally by flu and countless respiratory and intestinal virus infections. Still another virus disease of consequence to us is hepatitis. As a matter of fact, scientists suspect that viruses may turn out to be responsible for a great many of our disease problems for which they haven't been blamed so far. This is a fertile field for research.

Three aspects of March of Dimes studies in this area are particularly interesting. One is investigations stimulated by the discovery in the past decade or so of dozens of hitherto unknown viruses. Some of these viruses cause a disease similar to non-paralytic polio. Some are more serious and can cause paralysis, heart trouble, and death. Some are being studied to find out if, when they infect a mother-to-be innocently during pregnancy, they cause her child to be born malformed in some way.

Viruses today are suspected of two rather nefarious methods of operation. Both involve delayed-action effects. For example, can something as simple and seemingly innocuous as a case of measles in childhood do some hidden damage in the central nervous system that under some condition of stress years later in adult life, can cause serious trouble? Answer: It seems possible; and it is being investigated. Can some viruses "hang around," so to speak, in the body for years, doing no damage and giving no hint of their presence, only to be triggered by some stress condition into causing disease? Answer: This virus latency process also seems probable and is the subject of scientific study.

"Disorders of the central nervous system," an area The National Foundation has selected for concentrated research, sounds like a category separate to itself. Actually, work in this field is interrelated with other studies. Paralytic polio affects the central nervous system. So do other virus diseases. So do some birth-defect conditions. The category includes epilepsy, Parkinson's disease, certain kinds of blindness and deafness and a host of other disorders affecting millions of people. Using fundamental virus studies, cellular studies and metabolic studies, March of Dimes researchers will attempt to learn more about the central nervous system. Their aim will be not so much to attack specific disorders in this area as to gain fundamental new knowledge that may prove useful. Any promising lead in any direction will be followed up with a specific attack.



William J. Weaver, Age 3, Peoria, Illinois, is assisted by the Foundation which supports basic research on birth defects as Hydrocephalus. Aid is given to children from any age through age 18.

All research described so far is a natural outgrowth and extension of work National Foundation grantees were doing already in connection with polio. Even in arthritis research, this will be at least partially true. Viruses have not been ruled out as a possible cause of some forms of arthritis, and must be further investigated. Antibodies are also suspected of playing a significant part in the disease. When you know as little as is known today about arthritis, you start with very basic research. Studies in this area will involve fundamental body chemistry and more of the general "thinking small' approach that goes inevitably with work in metabolism.

The biggest arthritis problem is with a serious form known as rheumatoid arthritis, a connective tissue disease affecting the joints, the worst of the rheumatic cripplers. Its cause is unknown. Of several leads to be followed up by National Foundation grantees in 1959, two look particularly promising.

One of these clues involves a recently-discovered protein (called the rheumatoid factor) found in the blood of rheumatoid arthritis patients and not in the blood of persons who do not have the disease. A question needs answering here: Does the rheumatoid factor play some role in causing the arthritis, or is its presence a result of the arthritis?

(Continued on page 71)

Photographic Slides for Classroom Use

By CALVIN F. GRASS
Castleton Teachers College, Vermont

THE purpose of this article is to suggest a variation in the preparation of visual aids for use by the science teacher. Gradually making entry into the field are the 35-mm slides. The use of professionally made slides is limited by titles available; also, to some extent, by the cost factor. It is easily possible, however, for the teacher and/or students to make such slides at low cost. Even with limited equipment, an excellent variety of slides to meet instructional needs for several weeks can be made in a few hours. Imagination and resourcefulness are the only limitations on the variety that can be produced. A teacher can make a slide to suit *his* way of presenting a topic.

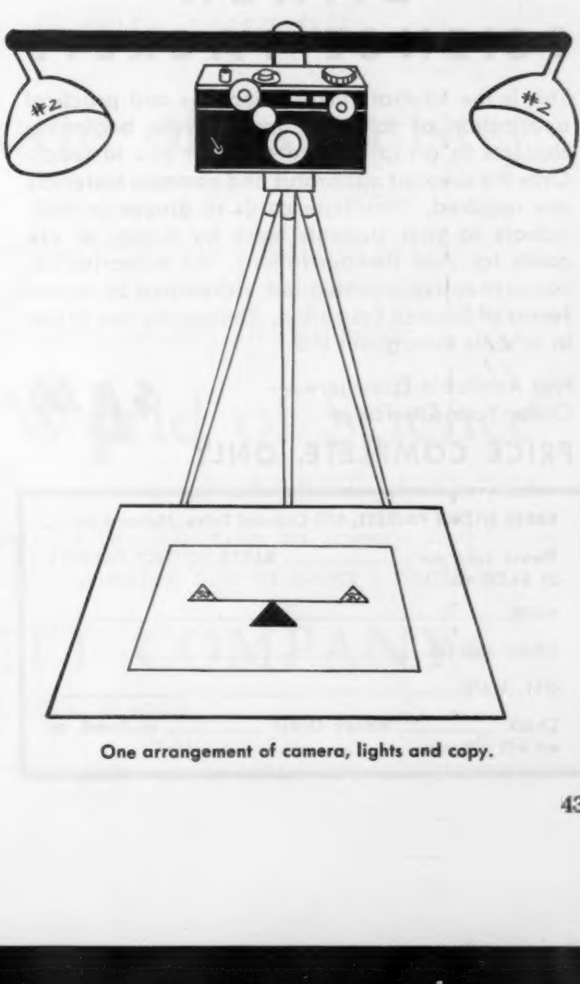
Only a few items of equipment and materials are necessary for the production of black and white 35-mm slides. These include: (1) a 35-mm camera, (2) a developing tank, (3) film, (4) chemicals (developer), (5) 2 photoflood lights, and (6) a few pieces of glass (some frosted, some plain), a few lights, any miscellaneous items. Other equipment may be purchased as the project progresses.

In preparing materials for slides the teacher must first determine what illustrations (visual) are needed. This includes serious consideration of the subject matter to be presented and the response desired. Diagrams, when recorded from a book, magazine, or newspaper, eliminate the necessity of a teacher taxing his artistic ability to reproduce a reasonable facsimile on the blackboard. Illustrative problems, when accompanied by appropriate diagrams and the solution, and projected on a screen, take on a new meaning for the student. The advantage of this, especially in large classes, is generally obvious.

Procedures

To prepare a slide of an illustrative problem, the teacher selects or makes up a problem which will serve his purpose. If a diagram is desired, an old workbook or text book may provide a ready-made sample, or a student with some artistic ability could be called upon to make a line drawing. The diagram or picture is mounted on a sheet of standard white construction paper. Below, above, or around this diagram, or picture the problem is printed. Plastic or rubber letters and ink pad can be used for printing the problem if desired. It is advisable to use black india ink so the lines of the hand-drawn diagram and letters will be as black as possible. Other "paste-ups" may be made to give the solution to the problem.

The camera is then mounted on a stand (airing stand will work) on a table and the two floodlights are mounted as in the diagram. Open the back of the camera and place a piece of ground glass opposite the lens. With the copy in place and floodlights on, adjust the height of the camera so the image on the ground glass nearly fills the rectangular opening. By moving the lights try to eliminate any shadows or glare on the copy. Adjust the camera lens so a sharp image is obtained on the ground glass. When using a small copy, a plus 2 lens fitted on the camera will make possible a sharp image.



One arrangement of camera, lights and copy.

The next step in the procedure is the making of a test strip. To do this set the opening of the diaphragm to f:8. Close the shutter and with the floodlights off (room lights may be on), insert a roll of microfile film in the camera. (Be sure to remove the ground glass before inserting the film.) After loading the film, turn on the floodlights and snap one shot of the copy at each shutter speed. It will be helpful later in selecting the proper shutter speed if this information is written on a small piece of file card and photographed with the copy.

Developing

After the desired number of exposures have been made, remove the film from the camera and, in darkness, load the film into a developing tank. Develop and fix the film, following the directions for time and temperature on the cans or packages. After fixing, remove the film and wash thoroughly. Following the washing, pass the film a few times through a wetting solution and hang up to dry.

When the film is dry, examine the strip (or run the film through a filmstrip projector) to select the time of exposure which gives the best negative. It may be helpful in the solution.

Test Strips

If the copy consists of diagram(s) and/or printed matter only, a negative transparency is acceptable. In this case, the next step is to set the time of exposure according to the information gathered from the test strip, insert a fresh roll of microfile film, and make one exposure of each copy desired (copies should be the same size). This film is then developed, fixed, washed, and dried. If individual slides are desired, the teacher has merely to cut the negative apart and mount in glass or cardboard frames.

If positive transparencies are desired, as would be the case with reproduction of black and white pictures, it will be necessary to print the strip of negative on unexposed film. To do this place a sheet of dull black paper on the table with a light (15 watt) suspended six feet above. With only the safe light on (in a dark room) place a piece of unexposed microfile (or positive) film with the emulsion side up on the black paper. Next lay the strip of negative directly on top of the unexposed film. Over this place a piece of *clean, unscratched* glass. To make a test strip place a piece of heavy paper on top of the glass. Turn on the white light (over the table) and move the black paper so that the film is exposed one frame at a time. Hold the paper at each position for one second. Thus the first frame will be exposed for one second,

the second two seconds, the third, three seconds, etc. After the whole film has been exposed, turn off the white light, load the exposed film in the tank, and develop, fix, wash, and dry as before.

After the strip of positive transparencies is dry, run it through a filmstrip projector to select the best exposure time. Once this has been determined, the procedure for making positives may be repeated using the new exposure time. The result will be a series of useful 35-mm black and white transparencies. These, when mounted, may be filed and used for years as the occasion arises.

Although any standard film developer may be used, the commercially prepared developer D-11 will give the greatest contrast. The microfile film may be purchased in 100-foot rolls inexpensively by exploring any current photography magazine for a source of supply; it can be loaded in the dark onto empty spools. Various types of film may be used. Microfile and/or positive film have been suggested because they will give good contrast.

As the individual teacher uses this procedure to make slides for classroom use he will realize that many refinements of technique and equipment are possible. These refinements, however, have been omitted in this paper in an effort to keep the procedure as simple as possible.

The Use of Ascaris in High School Embryology

By BROTHER JOSEPHUS, F.S.C.

Christian Brothers High School, St. Louis, Missouri

This report was an entry in the 1957-58 STAR (Science Teacher Achievement Recognition) awards program conducted by NSTA, sponsored by the National Cancer Institute, U. S. Public Health Service.

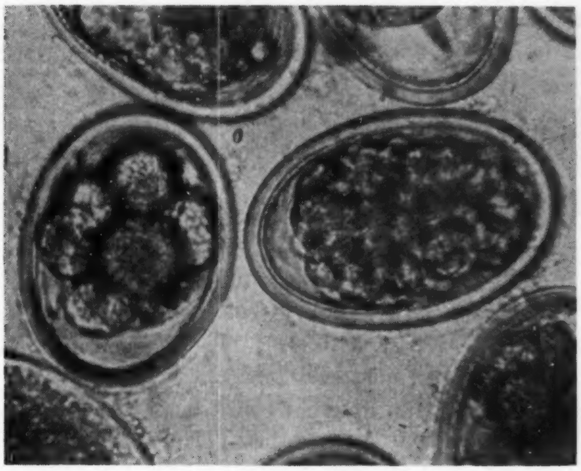
THE purpose of this paper is to present a laboratory method, whereby students can grasp the basic concepts of early embryological development in the most graphic way possible—that is, by actually observing the stages of cell cleavage in an organism. Ideal for this purpose is the nematode prevalent among pigs as an infectious agent, *Ascaris lumbricoides suum.* Its early developmental stages are easily observed and studied with a minimum expenditure of time and equipment. Furthermore, the importance of ascarids as parasites can be used to obvious advantage in the classroom.

Both the pig ascarid and the human have similar life cycles. In either case, egg development must reach the larval stage to be infective. The larvae are ingested and migrate from the intestinal tract through the circulatory system to the lungs. On reaching the traceal opening they are reswallowed, becoming adults and completing their life cycle in the intestine. Physiologically, the human ascarid is distinct from that of the pig. Infection of human beings by the pig ascarid is not known and is considered unlikely.

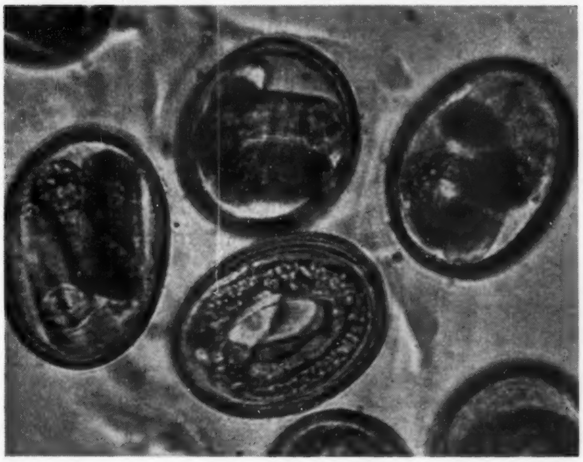
Fresh Ascaris worms may usually be obtained, gratis on request, from commercial packing houses on days they slaughter hogs. Rural areas where pigs are raised and killed are also excellent sources. Although the worms will be dead, the eggs are still viable and simple preservation of the worms in a salt solution plus refrigeration will provide a source of viable eggs for months. One of the remarkable qualities of living Ascaris eggs is their resistance to poisonous agents. They are known to continue segmentation even when fixed in formaldehyde.

The female worm is distinguished externally from that of the male in that its body is longer and relatively straight. An obvious posterior curve or bend is found in the male Ascaris. Students can perform the simple dissection of cutting along the dorsal line of the female. The uterus is usually paired and divergent and can be easily lifted out along with the very long and stringy ovaries. The eggs, already internally fertilized, are then teased out of the uterus. It is preferable to use about one inch of the uterine section closest to the vagina, as these eggs are ready to begin cleavage. The egg masses are placed in a dish, either in water or a weak saline solution, and incubated at a temperature between 20°-27°C. In the absence of an incubator, a moderately warm room will also give results. Within a day or two, most of the eggs will show segmentation. Development is continuous for a period of at least two weeks, but usually longer. At the end of this period, the motile larvae are formed and soon hatch from their shells.

Four-cell embryo



Eight-cell embryo



Larva within egg

Observations may be made by wet mounts as often as one wishes during the incubation period, using microscopes or a microprojector. It is even possible to stop the process at various stages by refrigeration, and recommence development by incubation. From the initial zygote stage, the students thus see progressively the development of the embryo or larval worm through the 2-cell, 4-cell, 8-cell, 16-cell, morula and finally the developed larva. The procedure that has been described is not only simple to carry out, but takes relatively little time on the days that observations are made.

It should be remarked that the Ascaris eggs have a very definite shell, although transparent. Unfortunately, it is not possible to observe mitotic figures. A teacher may supplement this project by purchasing slides that will show chromosomes as well as the blastula and gastrula stages.

Larva hatching

Student interest rises to a maximum as they observe the eggs developing. Also, their fascination at finally seeing the tiny larvae wiggling within their shells is in itself a convincing demonstration of the superiority of the "living" approach to biology. What phase of biology could be more exciting to youngsters than to actually witness, even in this small way, the "drama of life" unfolding before their eyes?

NOTE: The photomicrographs included with this paper were made by a student, Leslie Boll, who submitted an individual project on Ascaris development for our local science fair. His project was selected for exhibition at the National Science Fair of 1957.

Classroom Ideas

Chemistry, Biology, Math

The Pegboard in Sci-Math Instruction

By SISTER MARY EVELYN, O.P., St. Mary's High School, Orange, Texas [1]

This report was an entry in the 1957-58 STAR (Science Teacher Achievement Recognition) awards program conducted by NSTA, sponsored by the National Cancer Institute, U. S. Public Health Service.

FOR SEVERAL YEARS, the pegboard has been used for attractive displays in libraries and department stores. Its function as a science teaching tool is considered here.

Diagrams and pictures help convey ideas, but they do not equal the "real thing" or a working "3-D" model. Here, the pegboard steps in. The one-inch perforations make possible almost any arrangement of equipment, secured by string, heavy thread, or fine wire. Specific suggestions would include a display of apparatus for an identification quiz or a model to illustrate some process, as water purification. Such displays can be mounted and left in the classroom as long as needed, moved from room to room, or used in display cases. The entire display occupies only slightly more space than the board itself. Hardware stores and library supply companies carry all types of "gimmicks" for pegboard displays. However, the purpose of this report is to describe uses of the pegboard other than conventional display. Several teaching tools employing the pegboard were developed. Each may be used in lecture-demonstration by the teacher and in learning-through-participation by the student.

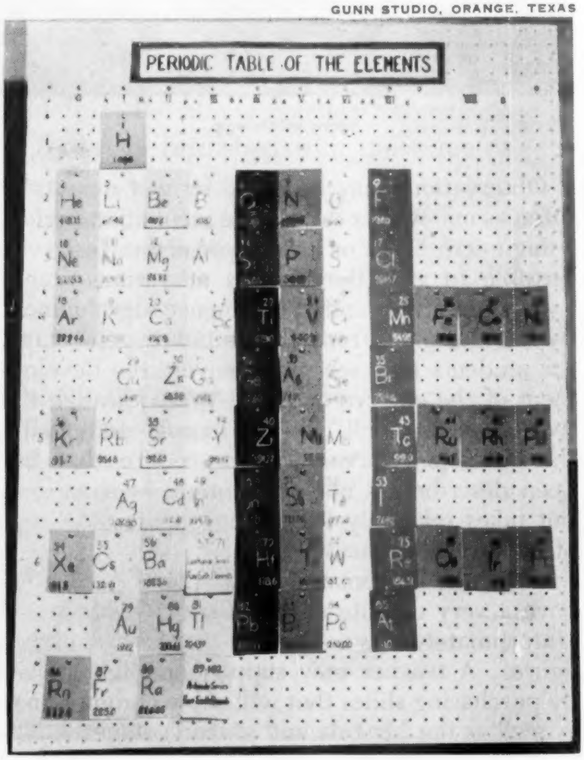
Periodic Table

The first display (Figure 1) aims to make the periodic table more meaningful to chemistry students. The idea of a variable periodic table was not original. It was taken from "A Variable Periodic Table" by Roderick Scheer, Waldoberscherle, West Germany in *Journal of Chemical Education,* November, 1955, (p. 590-591). The plan outlined in the article was modified considerably.

Using cards of different colors makes each "family" stand out from the others. Having a separate card for each element makes possible the conventional arrangement usually seen on standard laboratory charts and the long form used in many recent texts. In the "short" form, by stacking the cards and arranging them book-fashion on one fastener, the lanthanide and actinide series can be placed in their proper positions on the chart, rather than at the foot of the chart. A particular group of elements (metals, non-metals, etc.) may be spotlighted by placing only these cards on the board. The cards are attached to the board with ordinary brass paper fasteners.

Figure 1

GUNN STUDIO, ORANGE, TEXAS



[1] Sister Mary is now at Newman Hall, University of Texas, Austin, Texas, attending the NSF Institute program.

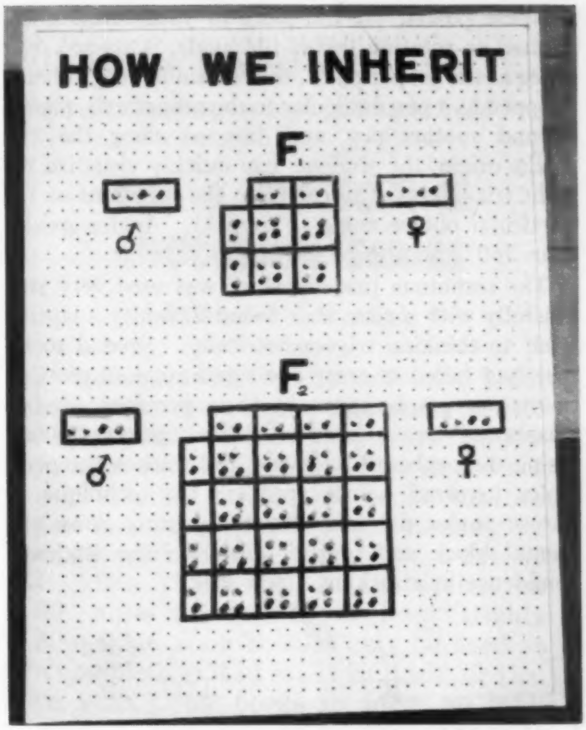
For the cards, ordinary construction paper was cut into 3″ x 4″ pieces. Color combinations are optional, but it might be suggested that black be used for group IV (carbon, etc.), light yellow for group VI (sulfur, etc), gray for the inert gases, and others. The symbol, the atomic number, and the atomic weight of the element represented were printed on each card, the "A" groups being printed to the left side of the card and the "B" subgroups to the right. Use of a stencil lettering guide is strongly recommended. The following captions are printed on strips; for the conventional form: $A^{I}B$, $A^{II}B$, etc., for the heads of the vertical columns, and 0, 1, 2, etc., to designate the periods running horizontally; for the long form: light metals, heavy metals, non-metals, and others.

Other captions may be made for spotlighting particular groups, such as "calcium family," "halogens," or "sulfides."

Heredity

To self-conscious teen-agers, heredity is an intriguing study. To illustrate Mendel's experiments and to chart the first and second filial generations, sections were drawn on the back side of the pegboard (Figure 2). The letters and symbols were cut from black construction paper and attached with poster wax. Golf tees were used to represent the genes. Two shades of green were used to represent one pair of dominant and recessive characteristics and white and yellow to represent a second pair. The latter colors were chosen as a pair because tees were purchased so colored. The greens were mixed until satisfactory difference was obtained. The tees were painted by being dipped in the paint. Wooden tees were used because of their solid heads contrasted with the hollow plastic pegs. Demco Library Supply Co., Madison, Wisconsin, sells a peg with a flat head similar to that of a thumb tack. These would be more satisfactory because of the uniform size of the peg portion. Kindergarten pegs, which come in boxes of assorted colors, might also be used. However, these have no "heads" and would not be as easily seen from a distance. Because of immediate availability, golf tees were used for our purpose.

To construct the illustrated display, 30 pegs of each color are needed—with a few extras to compensate loss. Any number of pairs may be provided. Any combination of genes in each "parent" is possible by merely changing the color of the pegs. This provides opportunity for endless predictions of possible offspring. The form drawn provides for two characteristics to be predicted simultaneously.



GUNN STUDIO, ORANGE, TEXAS

Figure 2

Of course, it may be used to predict the outcome of a single characteristic also. The pupils are encouraged to vary these experiments and to chart the results.

Choosing any "parents" produced by the F_2 generation, one may chart F_3, and so on. The "parents" are placed in their proper "boxes," then, their genes, in the transmittable combinations, are arranged in the spaces on the top and left sides of the chart. These combinations guide the arranging of genes in each "box." Pegs not in use can be aligned in the spaces below and to the sides of the chart proper.

Trigonometry

If the pegboard area is divided into four quadrants, it can be used to represent "giant-sized" graph paper for the plotting of points in algebra and trigonometry. Each hole may represent one unit on the graph. Pegs are inserted at the proper points. Fastening lengths of various colors of yarn to the center of the board makes possible vivid demonstration of the positions of the sides of obtuse angles and the determination of their functions as well as of the functions of the quadrantal angles.

For this demonstration two 36″ lengths of each color of yarn are needed. Pegs are placed at the proper points and the yarn drawn from the origin

to these points. If the piece of yarn forming the radius, or rotating leg of the angle, is passed over a peg at the proper point, the remaining length being dropped as a perpendicular to the proper axis, passed around another peg, and directed along the axis to the origin, the students can quickly visualize the right triangle used to calculate the functions of the particular obtuse angle (Figure 3). Angles greater than 360° can also be illustrated.

The technique just described was used very successfully with a class that found difficulty adapting itself to thinking trigonometrically. Several members had failed to grasp the significance of plotting points on graph paper in their previous algebra classes and were infected with a real "graph-phobia." Using the pegboard to review and reteach the principles involved before applying the technique to obtuse angles did much toward tearing down the mental block and toward bolstering the students' confidence in attacking a new task.

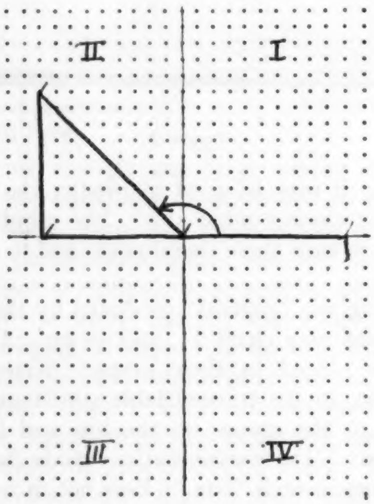


Figure 3

Pegboards and accessories may be purchased from most school or library supply houses. Or, a teacher with limited funds and less limited imagination might join the "do-it-yourself" trend. The pegboard used in the described demonstrations was purchased from a lumber company for \$1.92 (3′ x 4′ masonite ⅛″ pegboard). Wood strips for the frame cost an additional 86 cents. The board was painted with left-over wall paint. This made the surface washable and glare-free.

The described demonstrations are just a few suggestions. The ingenuity of the individual teachers is the only limiting factor to the teaching tools and techniques to be found in the pegboard.

Physics

Laboratory Rods as Sources of Sound

By GLENN H. BRAY, Grosse Pointe High School, Michigan and

PAUL C. SHARRAH, University of Arkansas, Fayetteville

Many science teachers, particularly high school science teachers, have at their disposal an inexpensive means of producing sounds of reasonably high frequency in their laboratories.

Practically every laboratory will have some steel or aluminum rods used with clamp and ring stands. If these rods are unscrewed from their bases and grasped firmly at the center with the thumb and forefinger and struck on the end by another rod, or better still, a steel hammer, they will ring with a high pitched note that will be quite musical. The fundamental frequency produced corresponds to a mode of longitudinal vibration of the rod which has a node at center and antinode at each end.

If one holds or clamps such a rod over a glass tube approximately a foot long and two or three centimeters in diameter, and gradually fills the tube with water while the tube is sounding, he can locate a resonance length with a short air column that is approximately one quarter wave length. This shortest resonance length is an air column which has to be corrected for the diameter of the tube. If one finds the next longer resonance length, which is approximately three times as long as the one found above, the difference in resonance column lengths will not be one half the wave length in air of the sound produced.

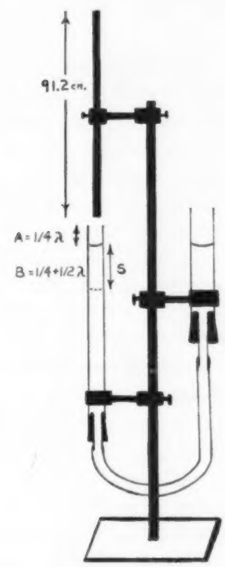
Using the formula $V_a = N2S$ where S now equals this difference of resonance lengths, and solving for the frequency N, one gets $N = \frac{V_a}{2S}$. The velocity of sound in air (V_a) is 331.5 meters per second plus 0.6 meters per second for each degree centigrade above zero.

Using the apparatus shown in the drawing, a short resonance length A for the frequency emitted by a 91.2 cm aluminum rod, was found to be 2.2 cm. The second resonance point was at such a length B that the difference ($B - A = S$) was found to be 6.5 cm. Using these data and the above formula, the frequency is

$$N = \frac{V_a}{2S} = \frac{332 + .6(20)}{2(6.5)} = \frac{34400}{13} = 2646 \text{ vib/sec}$$

Using this measured frequency, the velocity of sound in the rod can be found. If L is the length of the rod, the wave length of the sound is 2L or 182.4 cm. The velocity is

$V_R = N2L = 2646 \times 182.4 = 482{,}630$ cm/sec or 4826.3 m/sec



An accepted value for aluminum is 510,400 cm/sec. This gives a difference error of about 5 per cent.

Using this value of the velocity of sound in the aluminum rod, and the density of the metal, Young's modulus can be calculated with the formula as shown:

$V_R = \sqrt{\frac{Y}{d}}$ where Y = Young's modulus and d = density.

$$\text{We get } Y = dV_R^2$$
$$\text{or } Y = 2.7 \text{ g/cm}^3 \times 482630 \text{ cm}^2/\text{sec}^2$$
$$= 628837450000$$
$$= 6.28 \times 10^{11} \text{ dynes/cm}^2$$

The accepted values for aluminum fall between 6.28×10^{11} and 7.0×10^{11} for different alloys.

By the use of very simple equipment found in every laboratory it has been possible to (1) produce a very high pitched sound above that of the usual tuning fork, (2) find the frequency of the sound, (3) find the velocity of sound in the solid, and (4) find Young's modulus for the metal used.

In instances where none of this equipment is found, local industries often provide free rods of aluminum or steel.

SCIENCE TEACHING MATERIALS

Prepared by NSTA Teaching Materials Review Committee
Dr. Robert A. Bullington, Chairman
Northern Illinois University, Dekalb

BOOK BRIEFS

SCIENCE EXPERIENCES, ELEMENTARY SCHOOL. Bertha Morris Parker. 272p. $4.00. Row, Peterson and Company, Evanston, Ill. 1958.

This book, a revision of an earlier edition is written primarily for the elementary school teacher of the intermediate grades. The 181 experiences consists of directions for constructing simple science equipment or toys, written simply enough that they can be followed by intermediate-grade pupils. Many of the experiences are suitable also for younger or older children. Each experience includes a brief lucid statement of the science principle illustrated, most of which are taken from the often neglected area of the physical sciences. The experiences are classified according to the underlying science principle or concept, the book being organized into units such as: gravity, inertia, air, water, weather, magnets, and electricity.

SHOOTING STARS. Herbert S. Zim. 64p. $2.50. William Morrow and Company, Inc., 425 Fourth Avenue, New York 16, N. Y. 1958.

This well-known author of science books for children gives a very interesting discussion of the nature, appearance, composition, and occurence of meteors and meteorites, including a brief discussion of the solar system and its probable origin. Suitable for grades three through six.

WOODLAND ECOLOGY. Ernest Neal. 117p. $1.75. Harvard University Press, Cambridge, Massachusetts. 1958.

A report of a four-year study of an oak wood in England. Floral composition, habitat factors, animals, food cycles and relationships, adaptations, and succession are discussed. Ecological principles and methods of study are universal, so this interesting volume will give the high school and college biology teacher much useful information.

ANGLER'S GUIDE TO THE SALT WATER GAME FISHES—Atlantic and Pacific. Edward C. Migdalski. 506p. $7.50. The Ronald Press Co., 15 E. 26th Street, New York 10, N Y. 1958.

Biologists and fishermen will find this book by a fisherman-scientist a valuable guide to marine fishes. It covers identification, size, food habits, migration, life cycle, and habitats. Includes practical hints to the angler.

HOW ABOUT THE WEATHER. Revised Edition. Robert Moore Fisher. 172p. $3.75. Harper and Brothers, New York 16, N. Y. 1958.

The revised edition of a book originally published in 1951, written for the layman. Incorporates new maps and treats additional up-to-date topics. Cites common weather experiences and gives valid, scientifically sound reasons for their occurrence.

A TREASURY OF SCIENCE. Fourth Edition, revised. Harlow Shapley, Samuel Rapport, and Helen Wright, Editors. 776p. $6.95. Harper and Brothers, 49 East 33rd St., New York. 1958.

The new edition is once more as up-to-date as "Pioneer" and fascinating on every page. A must for every educational library and a bargain for the limited personal library.

EXPERIMENTS IN PHYSICAL SCIENCE. Allen D. Weaver and James F. Glenn. 196p. $3.00. Wm. C. Brown Company, Dubuque, Iowa. 1958.

Although designed for use in college physical science courses for general education, this excellent manual could also be used for high school classes. Includes 45 carefully tested experiments in all the topics usually included in physical science courses. Planned to illustrate the scientific method and to give a clear understanding of important principles. Pages perforated and spirally bound. An instructor's manual gives instructions and equipment lists for each experiment.

PROFESSIONAL READING

"My Daughter a Scientist!" By John C. Wright. *The Clearing House,* 33:142. November 1958. Programs for encouraging larger numbers of girls to become scientists may be futile.

"Plenty of Jobs." *Chemical Engineering News,* 36:31. October 6, 1958. Sixty-seven executives of this country's largest industrial firms give their opinions on the need for scientists and engineers during the next ten years. Should prove to be helpful information for teachers who must fill role of counselor for students interested in science and engineering.

"Starting Salaries Still Rising." By David A. H. Roethel, *Chemical and Engineering News.* 36:94-97. October 20, 1958. An analysis of the salaries currently being paid chemists by industries and academic institutions.

"Should General Science Be So General?" By Paul D. Preger, Jr. *School Science and Mathematics,* 58:710-12. December 1958. A new approach to junior high school general science.

"A Comparative Look at English, French and Soviet Education." By George Z. F. Bereday. *Educational Leadership,* 26:215. January 1959. A survey of French, British, and Soviet schools gives us insight into some of our own attainments and our own continuing problems.

"Science Research for High School Students." By Robert Silber. *Metropolitan Detroit Science Review,* 19:13. December 1958. Outlining steps a student may take to begin a research project and how to obtain help.

The Nature and Extent of Leadership in Conservation Education in State Agencies. By Richard L. Weaver. Department of Conservation, School of Natural Resources, The University of Michigan, Ann Arbor, Michigan. Report by the author summarizing a three-year investigation. (Limited number available on request.)

"A Witness at the Scopes Trial." By Fay-Cooper Cole. *Scientific American,* 200:121. January 1959. The author recalls the scene in 1925 when Scopes was tried for teaching evolution.

"What and Why of Underachievement." By Malcolm S. MacLean. page 69. "Evaluating Programs for the Underachieving Pupil." By Ray Graham. page 75. "Providing for the Underachiever." Fay C. Riley. page 91. "Problems in the Motivation of Gifted Children." By Frank T. Wilson. page 96. *The High School Journal,* Vol. 42, December 1958. Important subjects that bear a relation to each other.

"An Experience with the Gifted in a Regular First Grade." By Willard Abraham and Patricia Pejsa. *The Instructor,* 78:22. January 1959. Methods for teaching exceptional children how their bodies function.

"Growth and Variability—A Laboratory Experience." By John E. Butler. *The American Biology Teacher,* 20:208-10. October 1958. How to teach these biological functions using bean seedlings.

"Biology—An Anomaly." By George G. Mallinson. *The American Biology Teacher,* 20:248-50. October 1958. Explains why two biology courses—one functional and the other systematic—are needed.

"Science Teaching Improvement Program." By John R. Mayor. *Science,* 128:1262-65. November 1958. Indicating the gains in science education but need of increase in local interest.

How to Evaluate Teachers and Teaching. By Lester S. Vander Werf. 58p. 1958. Rinehart and Company, New York.

(Continued on page 72)

STAR '60 National and Advisory Committee Members

PHOTO BY CARL M. PURCELL, NEA

(Seated) Miss Louise Stakely, Atlanta Public Schools, Georgia; Mr. Robert H. Carleton, NSTA; Dr. Abraham Raskin, Hunter College, New York City; Dr. Margaret J. McKibben, NSTA. (Standing) Dr. Randall M. Whaley, National Academy of Sciences, Washington, D. C.; Mr. Virgil Heniser, Thomas Carr Howe High School, Indianapolis, Indiana; Dr. Harold S. Diehl, American Cancer Society, New York City; Dr. Ellsworth S. Osbourn, U. S. Office of Education, Washington, D. C.; Dr. Israel Light, U. S. Public Health Service, Washington, D. C.; Mr. James F. Kieley, National Cancer Institute, Bethesda, Md.; Dr. Murray Copeland, Georgetown University, Washington, D. C.; Dr. Ross C. MacCardle, National Institutes of Health, Bethesda, Maryland. Others serving on the committee but absent when this picture was taken are Dr. Milton O. Pella, University of Wisconsin, Madison; Mr. Kenneth E. Vordenberg, Public Schools, Cincinnati, Ohio; Dr. Dael Wolfle, Executive Officer, American Association for the Advancement of the Science, Washington, D. C. (See STAR announcement, page 25.)

Dr. Smith Goes to Washington

Dr. Herbert A. Smith, Professor of Education at the University of Kansas, has been appointed as Chief of the Science, Mathematics, and Foreign Language Section in the U. S. Office of Education, Washington, D. C. His appointment became effective January 5, 1959, as announced by U. S. Commissioner of Education, Dr. L. G. Berthick.

Under this assignment, Dr. Smith will carry major responsibility for the administration of Title III of the National Defense Education Act of 1958. He will be concerned with the strengthening of science, mathematics, and foreign language instruction in American schools. The Section which he will head is part of the Aid to State and Local Schools Branch of the U. S. Office of Education under Dr. John R. Ludington.

Dr. Smith has been in charge of the program for the education of science teachers at the University of Kansas. He has also been serving as Director of the Bureau of Educational Research and Services at K. U. He obtained his Ph.D. at the University of Nebraska in 1948, and was a faculty member there during 1947-1953. Dr. Smith served as an officer in the United States Navy during World War II.

Dr. Smith is a member of the American Educational Research Association, the National Association for Research in Science Teaching, and other educational and scientific societies. He has served as secretary of Section Q of the American Association for the Advancement of Science since 1956. Dr. Smith has been especially active in programs of the NSTA, having served on a number of committees and as a member of the Board of Directors in 1955-57. He was chosen as President-elect of the Association in 1957, and is currently serving as President. Dr. and Mrs. Smith have three children, Sandra 17, Barry 16, and Cynthia 9. The family plans to reside in Washington after the present school year.

National Training Laboratory for Education Leaders

The National Training Laboratory for Educational Leaders, sponsored by the National Training Laboratories of the National Education Association, will begin sessions at Gould Academy, Bethel, Maine, July 19 through August 7.

These sessions are designed to demonstrate various methods used to lay a foundation of theory of human relations and to give a background of relevant social science findings for the day's learning experiences.

Application should be made directly to National Training Laboratories, 1201 16th Street, N.W., Washington 6, D. C.

NSTA Activities

Convention Notes

Forms for advance registration and hotel reservations have been distributed to all NSTA members, and it is urged that everyone who possibly can should send in these forms and pre-register by mail. Attention should also be given to early registration for all meal functions and certain other sessions as a large attendance is expected and late action may lead to disappointments. As pointed out earlier, registration is a requirement for admission to all sessions.

New Headquarters

NSTA headquarters is now located on the 8th floor (809) of the new NEA building. We expect this will be our permanent "home" for a long time, without further moving or inconveniences caused when a new building is in progress. Those members who have visited us during the past ten years will share our feeling of relief and enthusiasm at this prospect—particularly, those who have visited our interim office suite of four rooms and three baths in the old Martinique Hotel!

With the new move, we want to decorate the office to make it representative of our service and those we serve. We are interested in receiving some clear, interesting, glossy-print photographs relating to the teaching of science at all grade levels. You may have been saving some appropriate pictures for just such a purpose. If what you have is suitable, please send them to us and we will have them blown up to proper proportions and displayed on the walls of our new office headquarters.

Elections Committee Report

The Elections Committee of the National Science Teachers Association met in Chicago on November 21 and 22. Those attending the meeting were Brother I. Leo, F.S.C., *Chairman,* Winona, Minn.; Mrs. Muriel Beuschlein, Chicago, Ill.; Mr. Virgil Heniser, Indianapolis, Ind.; Mr. Nelson Lowry, Arlington Heights, Ill.; Miss Mary Jane McDonald, Fond du Lac, Wis.; and Mr. Alton Yarian, Lakewood, Ohio. Mr. Robert H. Carleton, NSTA Executive Secretary was present in an advisory capacity. (Dr. Charlotte Grant, Oak Park, Ill., was unable to attend.)

The names of all suggested nominees submitted to the committee were considered. Since many members of NSTA who submitted names also suggested that more candidates be selected from the secondary schools, the advice is reflected in the listing of candidates for the various offices. The offices with selected candidates are:

President-elect: Mr. Richard H. Lape, Amherst Central High School, Snyder, N. Y.; Mr. Robert A. Rice, Berkeley, California High School

Treasurer: Mr. J. Donald Henderson, University of North Dakota, Grand Forks; Mr. Henry Shannon, State Department of Public Instruction, Raleigh, N. C.

Region I, Director: Dr. Frederick R. Avis, St. Marks School, Southboro, Mass.; Mr. Calvin F. Grass, State Teachers College, Castleton, Vt.

Region III, Director: Dr. Ruth Cornell, Wilmington, Delaware Public Schools; Brother Fidelian, F.S.C., St. John's College High School, Washington, D. C.; Mr. J. D. Reding, Treadwell High School, Memphis, Tenn.

Region V, Director: Mr. G. Bruce Hooper, Cuyahoga Heights, Ohio High School; Dr. Albert Piltz, Elementary Division, Board of Education, Detroit, Mich.; Mr. Herman L. Rider, Maine Township High School, Des Plains, Ill.

Region VII, Director: Dr. Sam S. Blanc, Gove Junior High School, Denver, Colo.; Dr. Horace H. Bliss, University of Oklahoma, Norman; Dr. Robert C. Sherman, North Texas State College, Denton.

The nominees, win or lose, are admittedly recognized by their co-workers as national leaders in science education. Their acceptances for nomination illustrate their willingness to serve fellow science teachers. Biographical data and ballots have been mailed to all NSTA members. Deadline for mailing marked ballots is March 15.

Publications Service

Effective immediately, all NSTA sales of publications will be handled directly by the Publications-Sales Section of NEA (Room 709), rather than by NSTA staff. All orders should be sent to them directly in the future.

We believe this action will provide more expeditious service to our members in the receipt and processing of orders for publications. With the growth in the number of our publications, and the increasing demands for these, it is no longer feasible for NSTA to attempt to operate its own small sales section. We appreciate this addition to the already large amount of service which is rendered to us by NEA.

FSA Activities

U.S. Registry

The U. S. Registry, reported in our October issue of *TST*, has been a successful venture. The Registry, a name list of high school teachers of science and mathematics, was made possible by an FSA grant and supplemented by a grant from the National Science Foundation. As of January 15, 1959, the list consisted of over 110,000 names of such teachers, and all of these names have been coded on punch cards which include date on specific teaching assignments and other pertinent information. These lists represent returns from about 75 per cent of the nation's secondary schools. The Registry, in various stages of completion, has been used nearly 200 times since December 1, 1958, to send professional information and materials to the teachers.

Teachers who may not have received the benefit of these mailings should be reminded that this is probably because the principals in their schools did not submit reports. Forms for making such reports are available on request to the NSTA headquarters.

SAA Program

The deadline is fast approaching for students to prepare projects and report them as entries in the 1958-59 program of SCIENCE ACHIEVEMENT AWARDS. The closing date for mailing entries is *March 15*, and they should be sent by first-class mail.

This program, now in its eighth year, annually attracts nearly 5000 participants. Equal sets of awards are given in each of eleven regions, and to each of the grade levels 7-8, 9-10, and 11-12. These awards consist of U. S. savings bonds, gold pins, school plaques, and award certificates. A special feature of the program is the provision of 22 special national awards of $100 each in bonds for projects that deal with metals or metallurgy. The total value of awards this year is about $14,000, the largest amount ever given for support of this program.

All students in U. S. and Canadian public and non-public schools are eligible. Entry forms and rules and regulations are available from NSTA headquarters. In making your request, please indicate precisely the number of students expected to participate with completed projects.

The SAA program is sponsored by the American Society for Metals and is conducted by the Future Scientists of America Foundation of NSTA.

Two NSTA publications which will be helpful to students in preparing their projects for entry in the SAA program are: *Encouraging Future Scientists:* Students Projects, 50¢; *If You Want To Do a Science Project*, 50¢.

Please direct inquiries for these books to the assistant executive secretary instead of the publications sales section of NEA.

Administrative Committee Meeting

The annual spring meeting of the FSAF administrative committee will be held in Washington, D. C., on May 9. This is the meeting at which program and budget for the following school year are prepared for submission to the NSTA Board of Directors. This year representatives of FSAF sponsors and other friends of the Foundation will be invited to an open meeting on May 8 for purposes of reviewing the FSAF program and offering recommendations and ideas for the administrative committee to consider. NSTA members and other science teachers are invited, in fact are urged to participate, in designing the FSAF program for 1959-60.

Comments, suggestions, and ideas should be sent to the chairman of the committee. Please direct your letters to: Dr. Stanley E. Williamson, Oregon State College, Corvallis.

FSAF Sponsors

Added to the roster of sponsors since December are the following business-industry organizations contributing financial support to FSAF.

Vanadium-Alloys Steel Company
Armco Foundation
The Martin Company
The Ampex Foundation
Mallory-Sharon Metals Corporation
General Airline and Film Corporation

N·S·T·A LIFE MEMBERS

The rate of increase in NSTA membership continues to be a great source of satisfaction to the national membership chairmen, the officers and directors, and to all members who share enthusiasm for the Association's goals and program. The membership count as of January 2, 1959 showed a grand total of 12,546 individual members. This includes 421 Life Members, to whose ranks have been added the following 23 persons since the last listing of new Life Members in the May 1958 issue of *TST*. Congratulations and welcome to the fold!

We also want to take this opportunity to thank those Life Members who have written us from time to time offering their encouragement and interest in this endeavor.

Life membership in NSTA is $175, if paid in 10 annual installments or $150, if paid in three years or less.

Blanc, Sam S., Denver, Colorado
Bull, Galen W., Terre Haute, Indiana
Cullmann, Ralph E., Eau Claire, Wisconsin
Curry, Nancy J., Wichita, Kansas
Davis, Allan Don, Channelview, Texas
Grant, Charlotte L., Oak Park, Illinois
Hamon, David, Pensacola, Florida
Hodge, Robert A., Fredericksburg, Virginia
Lee, Jack F. C., Pittsburgh, Pennsylvania
McKibben, Margaret J., Oak Park, Illinois
Migaki, M. James, Spokane, Washington
Neivert, Sylvia, Forest Hills, New York
Neumann, Richard L., Salt Lake City, Utah
Patten, J. Allen, Boulder, Colorado
Perkins, L. W., Narberth, Pennsylvania
Prather, Robert H., Dayton, Ohio
Reber, Paul L., South Bend, Indiana
Robinson, Walter E., Portsmouth, Virginia
Rogers, Evelyn C., McAlester, Oklahoma
Smith, Richard A., Palo Alto, California
Strouf, Donald L., Baldwin, Michigan
Taffel, Alexander, Bronx, New York
Wiebke, Almer B., Sterling, Colorado

Cartwright . . . from page 9

An illustration of how such information can be used to shed light on the past is given in the diagram shown. Figure 2 shows the actual temperature measured in the 300-meter deep bore hole drilled in 1957 at the Marie Byrd Station. Beneath the station the ice was found by seismic soundings to be about 3000 meters thick, extending 1500 meters below sea level. Dr. Harry Wexler (USWB), Chief Scientist for the U. S. Antarctic Programs, has studied the temperatures measured in this deep, icy hole. The snow at 45 meters depth, which was laid down approximately 150 years ago, is warmer than the surface by ½° C, apparently a result of a slightly warmer period which occurred during the past century, the warmth from which is propagating downward. Below this warm layer the temperature decreases at such a rate, that if extrapolated deep down in the ice, would indicate that the snow was deposited at a time when the climate was several degrees centigrade colder than now. Plans are under way to drill a hole clear through the ice to observe how far down the temperature decrease persists and at what level it begins to increase with depth—as it should under influence of the slow influx of heat from the earth's interior over the millennia. New data received from IGY weather stations will help to clarify the temperature changes.

But one of the most exciting possibilities that may arise from the hard-won data gathered by the meteorologist, is the use of his observations to learn more about the planetary winds of the earth and just how the atmosphere operates to maintain a reasonable balance between the excessively heated tropics and the frigid polar regions. One of the ways in which this problem will be studied is by calculating the movement of air northward and southward along a particular meridian and the amounts of heat and moisture carried along with it. To make such studies practicable special stations have been set up along five meridians. Naturally, all these meridians terminate at the Poles. Antarctic (and Arctic) stations thus become anchoring points for the entire system.

Weather Science Needs

These are exicting new prospects for the meteorologist whose science literally encompasses the globe and takes him to the ends of the earth in pursuit of it. Now he is looking outward into space, but the vistas are expanding more rapidly than the talents and resources needed to pursue them. Unless many more young prospective scientists set the sails of

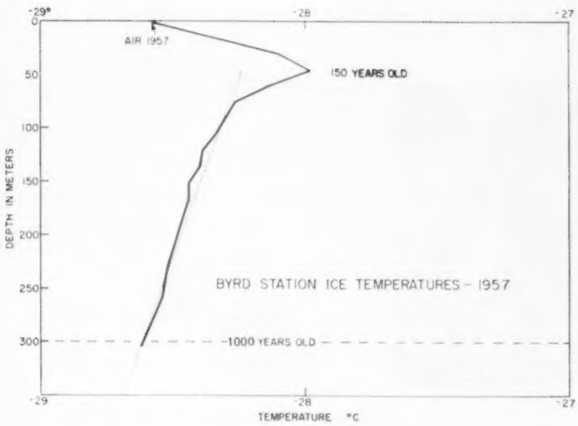


Figure 2

their careers to the winds of weather science, mankind must be denied some of the great benefits that can come from a more reliable knowledge of weather, its prediction and control.

Only a few of us can ever hope to study the atmosphere in the adventurous manner described here. But the atmosphere is all around us, and with a little patience and a few simple pieces of equipment anyone can learn some of the most fundamental processes that go into making the world's weather. Our continent still holds many secrets, and explorations of the earth and the atmosphere continually reveal new facts and data. Weather scientists are constantly needed to evaluate these findings, to probe, to prod, and to explore the many mysteries of our world. As a beginning for those interested in weather phenomena, experiments and references are listed below to direct you to an interesting and important field of exploration.

References

The following reprints from *Weatherwise,* a publication of the American Meteorological Society, are available on request from Dr. Vincent J. Schaefer, Director of Research, Munitalp Foundation Incorporated, RD #3, Schermerhorn Road, Schenectady 6, N. Y.

Simple Experiments in Atmospheric Physics Series:

"Home-Made Cold Chamber—1." 8:48-9. April 1955.

"Nuclei, Water Drops, and Ice Crystals—2." 8:68-71. June 1955.

"Forming Ice Crystals in a Supercooled Cloud—3." 8:101-3. August 1955.

"A Tornado Model and the Fire Whirlwind." By James E. Miller. 8:88-91. August 1955.

"Formation of Ice Crystals by Sublimation—4." 8:118. October 1955.

"Silver Iodide as an Ice Nucleus—5." 8:141-3. December 1955.

"Preparation of Snow Crystal Replicas—VI." 9:132-5. August 1956.

"Production of a Diamond Dust Shower—7." 9:195-7. December 1956.

"Formation of Large Ice Crystals in a Supercooled Film—8." 10:44-6. April 1957.

"Inside Antarctica, #1 LITTLE AMERICA." By Ben Harlin. 2:116-123. August 1958.

"Inside Antarctica, #2 Amundsen-Scott." By Edwin C. Flowers. 2:166-171. October 1958.

Reading References

Francis Bello. "Hurricanes." *Fortune,* p. 115. August 1956.

Ernst Behrendt. "What Science is Discovering about Hurricanes." *Popular Science Monthly,* 173:3. September 1958.

H. Wexler. "Antarctic Research during the International Geophysical Year." Reprint from *Antarctica in the International Geophysical Year,* Geophysical Monograph No. 1. 1956.

H. Wexler and Morton J. Rubin. "Antarctic Climatology and Meteorology." Reprint from *Antarctica in the International Geophysical Year,* Geophysical Monograph No. 1. 1956.

AO Reports on Teaching with the Microscope

Tranquilizers for Paramecium . . . or the care, feeding and observation of infusoria.

Generations of microscopists from Leeuwenhoek and Hooke down to present day biologists and medical workers have spent endless hours studying the ameba. You would think it had no further secrets left to fascinate present-day scientists. But not so! The ameba and its companion denizens of the primeval slime have come to us in unbroken genealogy from a period eons before the age of dinosauers . . . from the very beginning of creation itself. As a basic uni-cellular living organism, the ameba is more intensely studied today than ever before by scientists seeking the final elucidation of the life processes. Protozoa remain fascinating subject matter for student microscopists in the Biology classroom. With all this in mind, we offer the following generally well-known tips on the care, feeding and observation of the wee beasties.

MATERIALS:

Glass dish, approximately 8″ in diameter, 4″ deep (ordinary casserole pyrex dish); piece of plate glass; several petri dishes; timothy hay; pondweed; Methylene Blue; carmine or indigo powder; iodine; microscope slides; cover glasses; compound microscope; stereoscopic microscope.

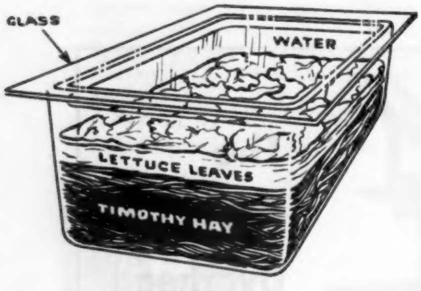


Fig. 1

HAY INFUSION:

Half fill 8″ dish with loosely packed timothy hay. Boil about two quarts of tap water for 5 minutes. Allow to cool and pour enough into dish to just cover hay. Add a 1 inch layer of the pondweed, Ceritophyllum. If out of season, or otherwise unobtainable, use unwashed lettuce leaves. Add more water to bring to within half-inch of top of dish. Cover with plate glass (see fig. 1). Keep in warm (normal room temperature), well lighted room . . . avoid strong, direct sunlight. Prepare several such cultures over a two-week interval. A brown, slightly odoriferous scum should appear. If scum disappears, or if whitish mold appears, discard culture. In a favorable culture, ameba will appear in 6 to 8 weeks. Additional protozoa will also be present, including Paramecium, Stentor, Euglena, and rotifers. Culture should thrive for 6 months or longer. Several such cultures will assure a plentiful supply of protozoa at all times during the school year. Occasionally add a malt tablet or few grains (pulverized) of rice as nutrient.

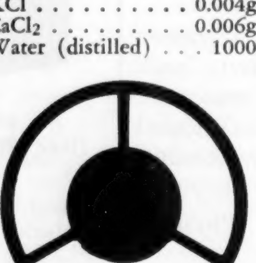
Fig. 2

OBSERVATION THROUGH STEREOSCOPIC MICROSCOPE:

Use a pipette to transfer some culture to petri dish . . . search the bottom of the culture dish for ameba, look along the sides where light is strongest for Euglena and look beneath decaying vegetable matter for Paramecium. Place petri dish on microscope stage. The stereoscopic microscope provides the unique advantages of three-dimensional magnification, long depth of focus and wide field of view to reveal, *in toto,* a teeming aquatic jungle of ameba, scooting paramecium, turgid rotifers and spinning ciliates (see fig. 2). If your school does not have a stereoscopic microscope, you may want information about the AO Spencer Cycloptic Microscope, Series 56F-1. Write to American Optical Company, Instrument Division, Dept. N95, Buffalo 15, N. Y. We'll be happy to send complete information at no obligation to you.

The stereoscopic microscope can also be used to establish "pedigree stock", or pure cultures. Simply hunt down the desired specimens with a wide mouth medicine dropper and innoculate a favorable culture medium such as Chalkley's fluid. Prepare Chalkley's fluid as follows:

$NaCl$	0.1gm
KCl	0.004gm
$CaCl_2$	0.006gm
Water (distilled)	1000cc



(*actual size*)

Fig. 3: Star diaphragm for dark field

OBSERVATIONS WITH THE COMPOUND MICROSCOPE:

DARK FIELD. It is difficult to see detail in live, unstained protozoa. Cutting down light intensity helps. If your microscopes have substage filter holders you can use star diaphragms to achieve dark field effect for better observation of general morphology. Make a star diaphragm out of stiff, black opaque cardboard. Use illustration (actual size) as pattern (fig. 3). Star diaphragm is slipped into filter holder and adjusted until best dark field effect is obtained.

STAINING. To see cilia, flagella and trichocysts, irrigate slide with very dilute iodine solution as follows: place drop of iodine at edge of cover glass on one side and place filter paper at edge of cover glass on opposite side. This will pull iodine under cover glass. To stain entire organism, proceed as follows: pipette some culture into Petri dish. Add Methylene Blue (not to be confused with Methyl Blue) until culture takes on definite blue tint. Observe drop of tinted culture under 10X and then 43X. Organisms will be stained blue for a short while and then gradually will return to normal.

FEEDING. To distinguish between food vacuole and macronucleus of ameba, add a pinch of finely pulverized Carmine or indigo powder to culture specimen on slide. Use cover glass and observe under 10X and 43X. Colored powder is rapidly ingested by ameba and accumulates in food vacuole. Powder grains can also be seen swirling into gullet of paramecium as they get caught in current set up by cilia.

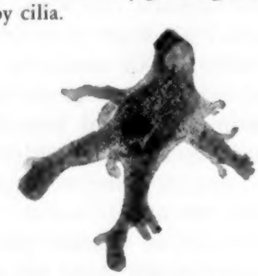


Fig. 4. Photomicrograph of an ameba

SLOWING DOWN PROTOZOA. If the ameba is the tortoise of their aquatic jungle, the paramecium is the hare . . . they literally flash in and out of field of view. Adding a drop of water soluble methyl cellulose (or egg albumen) will slow paramecium and other ciliates and flagellates considerably. You can narcotize them motionless with a small drop of very dilute methyl alcohol. Once anesthetized, your students can attempt photomicrography with their do-it-yourself photomicrographic camera set-up described in an earlier AO Report on teaching with the microscope. If you are using stains, you might want them to experiment with color film.

$25 For Your Experiment. We will pay $25.00 for each experiment involving either laboratory or stereoscopic microscopes accepted by us for future ads like this one. We're looking for unusual experiments suitable for the high school and junior college level. In the event of similar experiments the one bearing the earliest postmark will be used. The ad containing your experiment will bear your by-line. Write in now!

American Optical Company

Instrument Division • Buffalo 15, New York

Foundation . . . from page 41

The other clue concerns antibodies. Most people who know anything at all about antibodies think of them as good things to have, as things that defend the body from attack by foreign agents, including viruses and bacteria. Many scientists conjecture today that autoantibodies may be critically involved in the pain and swelling and tissue changes associated with rheumatoid arthritis. This hypothesis will undergo intensive investigation.

In fact, the future in medical research generally is full of exciting promise. This is true because so many scientists are dealing effectively with problems involving basic life processes.

With our limited ability to grasp space relationships, it is difficult to comprehend things on an Angstrom scale. But it should be no more difficult than comprehending the concept of a light-year as a measurement of distance. People tend to think the bigger a thing is, the better or more impressive it is. It might be well for us to train ourselves today to "think small' in preparation for understanding what medical scientists may be telling us about nature's secrets in the immediate years to come.

NATIONAL FOUNDATION HEALTH SCHOLARSHIPS

What —Four-year college scholarships for future health workers.

How many —At least one in each of five fields in each of the 49 states, District of Columbia, Puerto Rico, Hawaii (more in more populous states) anually.

Fields —Doctors, nurses, physical therapists, occupational therapists, medical social workers.

How much —$2000 each ($500 awarded annually depending on satisfactory performance).

Candidates selected—by appropriate committees in in each state made up of leading professionals in each field, appointed by The National Foundation.

Application—to be made to local county chapters of The National Foundation.

Start —with 1959 graduates.

Eligible —High school graduates for study in nursing, physical therapy and occupational therapy. Medical social work study beginning at college junior year level. Doctors beginning at medical school level.

As a regular feature of *The Science Teacher*, the calendar will list meetings or events of interest to science teachers which are national or regional in scope. Send your dates to *TST's* calendar editor. Space limits listings of state and local meetings.

February 19-21, 1959: National Association for Research in Science Teaching, Atlantic City, New Jersey

February 21, 1959: Council for Elementary Science International (CESI), Atlantic City, New Jersey

February 28-March 1, 1959: CESI, Cincinnati, Ohio

April 3-4, 1959: CESI, St. Louis, Missouri

March 31-April 3, 1959: Annual Convention, National Catholic Educational Association, Atlantic City, New Jersey

March 31-April 4, 1959: NSTA Seventh National Convention, Atlantic City, New Jersey

June 28-July 3, 1959: NEA Representative Assembly, St. Louis, Missouri

July 1-3, 1959: NSTA Annual Summer Meeting and business meeting of Board of Directors, St. Louis, Missouri

AUDIO-VISUAL AIDS

DAMS. Tells the story of the Shasta Dam and its role in controlling water for the Central Valley of California. The purposes of dams and the uses of impounded water are clearly explained. Useful in any course dealing with water problems. 14 min. Color $125. 1957. Pat Dowling Pictures, 1056 S. Robertson Blvd., Los Angeles 35, Calif.

WORKING WATER. The story of how desert land is made productive by irrigation. Methods of impounding water and preparing the land for use, and agricultural practices used in producing irrigated crops are shown. Very useful in a course covering water problems or farming practices. 14 min., Color $125. 1957. Pat Dowling Pictures, 1056 S. Robertson Blvd., Los Angeles 35, Calif.

SCIENCE FOR PROGRESS FILMSTRIPS. A set of twelve filmstrips in color designed as a supplement to general science in grades seven through nine. Each filmstrip begins with a key problem, covers scientific principles, and closes with review questions. The titles covered are Atomic Energy, Securing Your Food, Securing Good Health (in 2 parts), Light and Heat, Astonomy, Electricity, Communication, Water and Water Power, Transportation, Securing Continued Existence, Air and Weather. Prepared by Maurice U. Ames and David A. Waldman. 35 mm. Color, $38.00 per set. 1958. Prentice-Hall, Inc., Englewood Cliffs, N. J.

THE SUN AND HOW IT AFFECTS US. This film is effectively presented and combines the facts of astronomy with biology, physics and chemistry. Gives a better understanding of earth-sun relationships. Recommended for grades 4-6, but of value in junior high grades. 11 min. Color $110, B&W $60. 1958. Coronet Films, Coronet Building, Chicago 1, Ill.

HOW WE EXPLORE SPACE. Designed for use in junior and senior high science but useful at college level. Introduction to the instruments which astronomers use and their methods of obtaining information from outer space. Many of the facts which astronomers have learned are shown by time-lapse telescopic motion pictures of the moon, Mars, Jupiter, Saturn, and the sun. Rocket exploration of space is also shown. 17 min. Color only $150. 1958. Film Associates of California, 10521 Santa Monica Boulevard, Los Angeles 25, Calif.

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